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Sand Filters in Queensland.

In the *Mackay Sugar Journal* appeared recently some account of a pair of sand filters of improved construction supplied to the Racecourse Central Mill by Mr. George Cameron of the Mackay Ironworks. The filter consists of a cylindrical tank fitted with a central perforated pipe of cast iron, covered with fine wire gauze, and the intervening space is filled with sand, which is the filtering agent. The juice is fed into the filter by gravitation from a raised supply tank, and is distributed through the sand by means of a series of circular cast-iron plates; it leaves the filter thoroughly cleaned, and there is no choking up, as was the fault of the older style of filter. The two filters treat all the juice from the mills, putting through about 70,000 gallons in eighteen hours; they run for about ten hours without recharging with clean sand, which operation takes about twenty minutes.

Cuba.

After all, the Cuban Reciprocity Bill has been finally passed by the U.S.A. Senate, and President Roosevelt has got his heart's desire. Cuban sugar is henceforth to compete unfairly with the home-grown beet and cane sugar in the United States. But it is just possible that this undue favouritism may make things unpleasant for Cuba in other quarters. There are rumours that the Powers signatory to the

Brussels Convention have decided not to admit her sugars into their respective countries because she taxes foreign sugars above the limits allowed by the Convention. If this is true, then Cuban sugar will be shut out from the European market. Apart from this, it is also said that the different European Powers are stigmatising this Reciprocity Bill as a breach of the most-favoured-nation treaties, since Cuba is, for all practical purposes, a foreign country to the United States; and representations are being made at Washington to that effect. As far as England is concerned, so long as she remains a country of free importers, we know she is powerless to enforce the fulfilment of most-favoured-nation treaties; she can do no more than protest. But Germany and France can fall back on force if they think fit. In any case, if Cuba is going to extend her sugar manufacture some six-fold, as some would have us believe, she will require a vast quantity of new machinery, and it is hardly to be expected that European manufacturers will submit tamely to the United States booking the whole order. It is therefore evident that the Cuban question is by no means finally settled.

We are informed that Mr. Robert Harvey, M.I.M.E., head of the well-known firm of McOnie, Harvey & Co., Ltd., Glasgow, has opened an office at 27, Mark Lane, London, E.C., with a view to acting as a Consulting Sugar Engineer and Expert Adviser for the construction and equipment of cane sugar factories. He has taken this step believing that the altered conditions now prevailing in the sugar world will give such an impetus to the industry that a very large demand will shortly ensue for more modern equipment, without which no hope of improvement is to be expected. London being the most central spot for transacting business, this step on Mr. Harvey's part should prove an advantage to all parties. It is almost unnecessary to point out that Mr. Harvey has had so many years of varied experience in connection with sugar estates all over the world, and in the designing and construction of cane sugar factories, that we think he can confidently undertake the role of expert adviser.

The sugar duties in Mauritius were reduced on November 10th last as follows:—

	Old rate. Rs.	Old rate. Cts.		New rate. Rs.	New rate. Cts.
Sugar, per 100 kg... .. .. .. Sugar candy, per 100 kg...	3	60	....	3	46

SUGAR PRICES AND CONSUMPTION SINCE SEPTEMBER 1st, 1903.

(F. Sachs in the *Sucrerie Belge.*)

As a consequence of the International Convention concluded at Brussels on March 5th, 1902, Germany, Austria-Hungary, France, Belgium, and Holland have, since the 1st September, 1903, suppressed all the direct and indirect bounties which the sugar industry in those countries had hitherto enjoyed. In the case of three, viz., France, Belgium and Germany, they have furthermore reduced the excise duty levied on sugar sold for home consumption.

The natural result has been the lowering of prices and an increase in the consumption in each of the countries just cited.

We may as well see to what extent this has taken place, at the same time noting the conditions in Great Britain by way of comparison.

1. Price of Sugar in Home Markets.

1903.		31st July.		31st October.
London, Tate's Cubes, per cwt.	sh.	18·00	..	18·3
,, Austrian Granulated, per cwt.	sh.	9·10½	..	10·3
Madgeburg, Refined (loaves) per 50 kg.	mk.	29·70	..	20·07
Vienna ,, ,, ,, 100 ,,	k.	85·00	..	66·30
Paris ,, ,, ,, ,,	fr.	93·25	..	58·75
Brussels ,, ,, ,, ,,	fr.	85·00	..	53·00
,, Crystallised	fr.	75⅛	..	46·00

Here, in spite of a slight rise in the price of sugar on the London market, there has been a considerable reduction in the price of sugar in France, Belgium, Germany, and Austria-Hungary.

2. Increase in the Consumption of Sugar.

If we compare the quantities of sugar which have been declared "in consumption" in the cited countries during the months of September and October, 1903, with those in the corresponding months of 1902, we obtain the accompanying table indicating the consumption of each country in tons of refined sugar.

Country.	Sept. and Oct. 1903. Tons.		Sept. and Oct. 1902. Tons.
Germany	234,020	..	148,574
Austria-Hungary	83,517	..	65,191
France	202,867	..	79,124
Belgium	23,228	..	10,000 (?)
Holland	30,044	..	23,051
Great Britain	232,088	..	231,232
	805,764	..	557,172

being an increase of 248,592 tons of refined sugar, or 276,213 tons in raw for the two months of September and October alone in the six countries.

If the price of sugar in the world's market has not risen in spite of the increased consumption, the reason of it is, in our view, chiefly due to the considerable stocks of sugar at present existing in the market. These stocks are mostly in the hands of merchants who acquired them during the previous year at a very low price, and are consequently able to sell them with profit at the present ruling price. When the larger part of this stock has been exhausted, it will be necessary to take into account the position of the European *fabricants*, of whom the majority (especially in France and Belgium) will not be able to work profitably at present day prices for sugar and beets. And if it becomes necessary next year to reduce the price of beets, there will inevitably follow a reduction of the sowings and *ipso facto* of production in 1904-05.

CUBA.

Since the outcome of the war between Spain and the United States, the old Spanish colony of Cuba has been the object of considerable attention on the part of American capitalists. This is not surprising when we consider the variety and the abundance of its natural resources. In order to realize them it required, in the first place, capital, then the co-operation of agriculturists, manufacturers, and intelligent go-ahead merchants. All these elements were easily placed at Cuba's disposal by the United States. Appreciating on her own part the significance of thoroughly exploiting the resources of the "Pearl of the Antilles," the United States Government endeavoured to obtain for its own subjects the most accurate information possible with regard to the economic conditions of Cuba. A recently-issued official document offers, from this point of view, a most instructive picture of the situation in the Great Antille.

Cuba is situated entirely within the torrid zone, yet the island is nowhere found so far south as to render its climate, strictly speaking, a tropical one. The temperature scarcely differs from that of the States on the Gulf of Mexico, although the amount of its rainfall is more considerable. As regards its salubrity, it has made considerable progress of late, and thanks to hygienic measures enforced with all strictness throughout the island subsequent to the American occupation, the yellow fever which prevailed so much but a short while ago has now completely disappeared, as is shown by the fact that not a single case of it has been reported for two years.

The island population, according to the census of 1899, attained to the figure of 1,572,797, a reduction of 8 per cent. as compared with

that of 1887. From the commencement of the war in 1895 down to 1899, the population appears to have decreased by 200,000 souls; but it is certain that since 1899 it has appreciably increased, and, according to the best authorities, has reached by now a total of 1,630,000. The 1899 census proportioned the population as follows: Whites, 67·9 per cent.; coloured, 32·1 per cent. Since 1861 the proportion of whites has increased, and that of coloured people decreased. Classified according to their nationality, the 1,572,797 individuals of 1899 comprise: 1,400,262 Cubans, 129,240 Spaniards. 14,863 Chinese, 12,953 African negros, 6,444 Americans, 1,968 Spanish Americans, 1,179 French, 731 British, 501 Italians, 248 Germans, and 4,272 various.

The density of the Cuban population varies considerably; it amounts to about 153 to the square mile in the province of Havana, 55 in that of Matanzas, 37 in Santa Clara, 35 in Pinar del Rio, 26 in Santiago, and 8 in Puerto Principe. In other words, the density of Havana equals that of the State of New York, and is as scanty in Puerto as in the State of Washington. The average density of population in Cuba is slightly higher than that of the United States, but in the former there exists a much larger proportion of uncultivated or uninhabited land. Practically the whole of the uncolonized tracts are suitable for intensive cultivation, whereas in the U.S.A. immense stretches are unredeemable owing to their aridity and difficulty of access. It is estimated that Cuba could nourish and support in comfort a population of at least fifteen millions of inhabitants. This represents 340 persons to the square mile, a proportion inferior to that of Rhode Island or Massachusetts where life is easy, and to that of many tropical countries. In Java, for instance, the population is much denser, being about 570 to the square mile.

From an agricultural point of view, Cuba is admirably endowed; she possesses pastures, fruits, products of coffee, sugar, tobacco, gum, building woods, &c. The island is equally rich in valuable mineral resources. But the two principal products of Cuba are sugar and tobacco. The sugar cane was introduced into Cuba soon after the discovery of the island. In 1830 Cuba produced 100,000 tons of sugar; before the war she had increased the annual amount by ten-fold. The sugar is harvested in an almost similar manner all over the island; the bulk of the production is furnished by the four central provinces of Havana, Matanzas, Santa Clara and Puerto Principe. The cane develops with remarkable ease, with but little labour, and only requires renewing every 10 or 15 years.

According to actual returns, the cost of producing sugar in Cuba works out on the average at one cent per pound (11·43 fr. per 100 kg.), and the cost of manufacture and transport to port of shipment does not exceed another cent per pound, so that the total cost of the sugar, from the cane plantation to the shipment at Havana, comes to about

two cents per pound. This figure is about the lowest attainable, and in many cases it is a bit higher.

At one time the cost of production was much greater. But thanks to the improvements in the processes of cultivation and manufacture, and in the conditions of manual labour, thanks also to the abolition of oppressive taxes and restrictive tariffs, the net cost has been reduced to an appreciable extent.

The largest sugar crop hitherto reaped in Cuba was that of 1894, which slightly exceeded 1,000,000 tons. She possessed a cultivated area of 2,000,000 acres, of which 400 to 450 thousand acres are planted with cane. For 400,000 acres the yield was 25 tons per acre. In 1899 47 per cent. of the total area cultivated was planted with cane. The total area was about 1,000,000 acres. To that one has to add the area occupied by towns, farms, and pasturage, in which case the total is calculated at fourteen million acres, or half the whole area of the island; the other half also lends itself to fruitful exploitation. It is no exaggeration to declare that the two million acres of 1894 could easily be increased to 5,000,000, all devoted to the economic production of the sugar cane.

Since the beginning the sugar harvests have undergone considerable variation, either through war, or else meteorological incidents, in particular cyclones, and changing economic conditions. In 1853 the sugar crop amounted to 322,000 tons; in 1868, at the beginning of a ten years' war, 749,000 tons; the 1871 cyclone reduced the crop in that year to 547,000 tons; in 1878, at the end of the war, Cuba produced 553,000 tons. The 1883 crop, influenced by unfavourable political crises, was about 460,000 tons; that of 1894, on the eve of the last revolution, attained to 1,054,000 tons; in 1897, after this revolution, it had fallen as low as 212,000 tons; in 1900, a dry year, it was no higher than 308,000 tons. Finally, in 1903, it has risen to over 975,000 tons.

The Report of the Hon. Robert P. Porter, special commissioner of the United States to Cuba in 1889, contains careful instructions on the proportioning of cultures and the parcelling out of the agricultural property in Cuba. Just after the war the cultures were apportioned as follows:—

Sugar cane, 47·3%; sweet potato, 11·3%; tobacco, 9·3%; bananas, 8·6%; maize, 7·3%; malangas, 3·4%; cassava, 3·2%; coffee, 1·6%; cocoanut, 1·4%; rice, 0·5%; cacao, 1·4%; yams, 0·3%; Irish potatoes, 0·3%; pineapples, 0·3%; oranges, 0·3%; and onions, 0·2%.

With regard to the number and magnitude of the Cuban farms, the 1899 census gave the following results in caballerias of $33\frac{1}{3}$ acres:—

	Number of farms. Per cent.		Per cent. of surface cultivated.
Less than ¼ caballeria..	63·5	....	15·5
From ¼ to ½ ,, ...	19·2	....	12.5
,, ½ ,, ¾ ,, ...	8·0	....	9·5
,, ¾ ,, 1 ,, ...	2·1	....	3·5
,, 1 ,, 3 ,, ...	5·1	....	16·1
,, 3 ,, 5 ,, ...	0·9	....	7·0
,, 5 ,, 10 ,, ...	0·7	....	9·0
More than 10 ,, ...	0·5	....	26·9

Thus 63·5% of the farms are less than one-quarter caballeria, whilst large plantations of 10 cab. or more only represent 0·5% of the total. Some large farms, however, comprise plantations of 5,000 to 25,000 or more acres.

At one time the farmer worked up his own crop; in the course of time that system was replaced by that of "colonias," or farmers who sold their canes to the large mills. Some plantations combine cultivation and manufacture; these are termed "ingenios." The combination of several "ingenios" forms the "centrale." The greater part of the sugar manufactured in Cuba finds an outlet in the United States, as is shown by the following table:—

Year ending June 30th.		Harvest. Tons.		Exported to U.S.A. Quantity. Tons.		Exported to U.S.A. Value. $.
1893	....	845,894	....	823,058	....	60,637,670
1894	....	1,054,214	....	949,778	....	63,147,745
1895	....	1,004,264	....	824,001	....	40,100,180
1896	....	225,221	....	488,023	....	24,102,835
1897	....	212,051	....	257,942	....	11,982,473
1898	....	305,543	....	196,529	....	9,828,607
1899	....	345,260	....	296,225	....	16,412,088
1900	....	308,543	....	314,936	....	18,243,644
1901	....	635,856	....	490,805	....	26,373,690
1902	....	850,181	....	439,382	....	18,205,359
1903	....	975,000	....	1,069,600	....	42,697,546

The total value of the sugar exported to the United States is, as seen above, a very variable figure; different causes have been answerable for this; such as the disturbance and destruction wrought by the war, the suppression of commercial treaties with the United States; the lowering of the world's price owing to the influence of beet, &c. In considering the influence of the United States' tariffs, if we note the results of four typical years: that of 1890 under the old Spanish regime; 1893 under the reciprocal regime adopted in 1891; 1896 under the regime of non-reciprocity established in 1892; and 1901 under the actual tariff, we see that it is under the reciprocal regime that the total value of the commerce between Cuba and the

United States attained its maximum. That of sugar and molasses, in particular, had the following results for the four years cited :—

	Value in Dollars. Imports into United States. Total.	Sugar and Molasses.
1890	53,801,591	39,099,670
1893	78,706,506	61,718,665
1896	40,017,730	24,231,309
1901	43,423,088	27,364,866

From that time it was clear that the reciprocal treaty, which has been incessantly submitted for the approval of the American Congress, will exercise a clear stimulating action on the exports of Cuba to the United States, especially in the case of sugar.

For some time past, as mentioned above, the capitalists in the States have had their eye on the agricultural and mineral resources of Cuba, with a view to making the most of them. An estimation of the American capital invested in Cuba enterprises is of some interest here. In 1894, the year preceding the insurrection, 50 millions of dollars was stated to be its value, invested in property and various enterprises. In 1902 the amount of American capital invested in Cuban sugar alone was estimated at 40 million dollars. This sum was divided pretty equally between Cuban capitalists having received letters of naturalization, and capitalists who were citizens of the United States in their own right. Since then, the influx of American capital has continued. According to the report of Mr. Steinhart, consul-general of the United States in Havana, dated August 18th, 1903, the actual division of American capital in Cuba is as follows :—

	Millions of Dollars.
Sugar Plantations	25
Tobacco (cultivation and factory)	45
Fruit Plantations	3·5
Mines	5
Cuban Railways	12
Tramways	8
Real Estate and various Commercial Enterprises	1·5

Thus the United States possess in Cuba a working capital of fully 100 million dollars, of which a quarter is invested in sugar plantations. No doubt this proportion of American capital will go on augmenting, especially if the reciprocity treaty becomes law and if its effects fulfil the anticipations of the sugar planters.

There is another factor of a nature to attract American capital to Cuba; we refer to the situation newly created by the abolition of bounties on beet sugar. The official document of the Statistical Bureau at Washington, from which we cull these notes, discusses at some length the Brussels Convention, and endeavours to point out

the economical consequences of the abolition of bounties and of the reduction of the sugar duties in different countries; it sees in this double reform a decided encouragement for the colonial industry, it suggests that the near future will bring in its train a sounder and more normal development of the sugar industry in general. It can hardly be doubted that an international regulation of sugar matters in Europe will in the long run prove profitable to tropical sugar lands: first, by maintaining more even and higher prices; second, by the greater facilities for disposing of their sugar in the neutral European markets. In the case of Cuba, however, its geographical proximity to the United States will, apart from the latter's large financial interest in the sugar industry of the island, most probably avert the possibility of a diversion of Cuban sugar to new markets.

Dealing with this question, Consul-General Steinhart furnishes some notes worthy of attention, in response to questions which had been addressed to him by his Government.

1. What is the approximate cost of sugar per pound under favourable conditions and with modern methods and plant? In Cuba, he says, the cost is certainly two cents per pound (22·85 fr. per 100 kg.), although certain plantations particularly well situated, having narrow-gauge railways and other modern means of transport, are able to produce sugar at $1\frac{1}{4}$ to $1\frac{5}{8}$ cents per pound; but these plantations are limited in number, and cannot serve as the basis for an average. The cost of culture per caballeria of canes is on the average as follows:—

	Dollars.
Preparation of the soil	415
Sowing	120
Planting	283
Machine cultivation	383
	1201

The mean cost of cutting and transporting is about 90 cents per ton (2,240 lbs.) of cane. A caballeria of good soil yields, on a five years' average, about 614 tons of cane. On virgin soil 1000 tons can be obtained. (This corresponds to 18·42 tons per acre, and the 1201 dollars per caballeria is equivalent to about £7 10s. per acre.) The ton of cane yields from 195 to 235 lbs. of sugar, according to the process of manufacture and the skill of the workmen.

2. What is the proportion of sugar manufactured under modern conditions? Only 12%; the remaining 88% is turned out by obsolete methods.

3. What is the increase in production from employing modern plant? Under the old methods the yield of sugar was from $8\frac{1}{2}$% to 9% on the weight of cane. With modern conditions, it varies from

$10\frac{1}{2}\%$ to 11%. In the opinion of competent persons, the obtaining of still higher yields will depend chiefly on the perfecting of cultivation. In Java old methods yield 14% to 16% of sugar (but here the writer fails to take into account the high degree of perfection to which technical skill has been carried in the Java sugar industry).

4. What is the total area devoted to cane sugar? The agricultural sources of Cuba have never been more than partially utilized. The largest harvest, that of 1894, yielding 1,054,214 tons, was obtained on but a small portion of the area of soil suitable for cane cultivation. Cuba at the present day is an undeveloped island, but possessing infinite resources. Her actual population is but a fraction of that which could exist, and which is moreover needed in order to enable her to be fully exploited. The area of sugar soil is about 51,344 caballerias; of this only 12,784 are at present employed.

5. What is the probable capacity of the island's production under modern methods? In order to answer this question, it is proper to point out that not only must modern methods be taken into consideration, but also the question of immigration, a past and present problem that seriously occupies public opinion in Cuba. One of the principal factors in the development of agriculture is evidently hand labour; but, as pointed out, this is a necessary asset which is wanting in Cuba, and in consequence salaries are very high, thus increasing the cost of production. In general, public opinion is favourable to the immigration of white labourers. Experience has shown that the labourers provided by the Canaries and North Spain have been quite capable of undergoing the rigours of the Cuban climate, and make good agriculturists. The Southern States of the U.S.A. likewise furnish good material for Cuban hand labour. With sufficient of the latter, it is no exaggeration to claim that Cuba could turn out 6,000,000 tons of sugar per annum.

Thus, according to Mr. Steinhart, Cuba, under suitable organization, will be in a position to produce six times as much sugar as she does at the present day. This quantity is almost equivalent to the production of Europe or 60 per cent. of the world's supply. It will of course take a good number of years to attain this result, and by that time fresh markets will doubtless be opened to the cane and beet sugar producers of the world. But, in any case, the economic evolution of a country, capable one day of such an output of sugar, surely demands the serious attention on the part of the sugar world of to-day.—(From the *Journal des Fabricants de Sucre.*)

The contract for constructing a Central Sugar Factory in Antigua has been secured by the Mirrlees Watson Co., of Glasgow.

THE WEST INDIA COMMITTEE'S BANQUET TO SIR NEVILE LUBBOCK, K.C.M.G.

The 25th of November last was certainly a red-letter day in the annals of the West India Committee. It was the date on which a presentation was made, and a banquet given, to the man whom, of all others, the Committee "delighted to honour." It was deemed a fitting opportunity to make some public recognition of the long, arduous and untiring services of Sir Nevile Lubbock, their chairman, during so many past years, when he fought so hard for the salvation of our West Indian colonies, and for the abolition of the Continental sugar bounty system. Until the Brussels Convention had been fully ratified by the British Government, and the Bill to carry out its provisions had been safely passed through both Houses of Parliament, it was not considered advisable to make any definite arrangements, so that although the scheme was first mooted in the early spring, it was only last month that it was carried into effect; and we certainly think that the delay was justified, when we consider on how much broader a basis the celebrations were now rendered possible, than would have been the case six months ago, when the proverbial "slip" was within the bare bounds of possibility. But with the danger fully over, there was no feeling of uncertainty to mar the proceedings, and the West India Committee are to be congratulated on the very successful results of their effort to do fitting honour to Sir Nevile Lubbock.

They have brought out a special number of their circular in which figures a verbatim report of the day's proceedings, and several excellent plates by way of illustration. We are indebted to this report for our more or less abreviated account of the function.

The presentation consisted of a most excellent portrait of Sir N. Lubbock, by Prof. Hubert von Herkomer, to whom he had given the necessary sittings in the course of the past summer; a massive set of silver centrepieces and candelabra; together with a diamond crescent tiara for Lady Lubbock. These were presented at a banquet given in his honour at the Whitehall Rooms, Northumberland Avenue. Here a most representative company assembled, of whom the following are but a few:—The Right Hon Sir James Fergusson, Bart., G.C.S.I., G.C.I.E., M.P. (who occupied the chair); Sir Nevile Lubbock, K.C.M.G.; His Grace the Duke of Marlborough, K.G., His Majesty's Under Secretary of State for the Colonies; the Right Hon. Lord Stanmore, G.C.M.G.; Sir Henry Bergne, K.C.B.; Sir Alfred L. Jones, K.C.M.G.; Sir Henry K. Davson; T. J. Pittar, Esq., C.B., C.M.G.; George Martineau, Esq., C.B.; M. Yves Guyot; Arthur A. Pearson, Esq., C.M.G.; Mr. Claude T. Berthon, Mr. Alfred Chapman, Mr. C. J. Crosfield, Mr. Robert Harvey, Mr. George Hughes,

Mr. Robert Kerr, Mr. John Laidlaw, Mr. John McNeill, jun., Mr. Andrew McOnie, Mr. F. I. Scard, Mr. W. P. B. Shepheard, Mr. Edwin Tate, and Mr. Algernon E. Aspinall. Letters of regret for unavoidable absence were received from, *inter alia*, Mr. Alfred Lyttelton, Mr. Chamberlain, Lord Avebury, Sir Edward Grey, Sir Henry Primrose, Mr. Bonar Law, Mr. Platt-Higgins, Mr. James Reid, and Sir Howard Vincent.

After the usual toasts, the Chairman rose to propose the guest of the evening. He said:—

We are here to-night at something like a celebration (hear, hear), a celebration in which my friend on my right holds a predominant place, a victor after a long battle triumphing in the interests of his fellow countrymen. (Cheers.) I have seen some phases in colonial administration. I am old enough to remember when the differential duties were abolished which gave an advantage to the West Indian Colonies, and I remember how it was foretold that the decline of the West Indies would succeed. There was in those days a school of politicians who were somewhat hard-hearted. They did not mind what became of the British colonies provided they could get things cheap in this country. We were rather like an old woman of whom I remember my grandfather used to tell a story, who when she was told there was a very bad season in the West Indies, and sugar would be scarce, replied—"Well, I am very sorry for Jamaica, but I get all my sugar from Dundee." (Laughter.) And so there are some who would not care if the oldest colonies of the British Crown were to go under altogether, provided they could get the commodity that suited their trade best, below price. . . . . Well, times have changed. (Cheers.)

The colonial connection is valued and the attachment of the Colonies to the Mother Country is reciprocal. (Hear, hear.) Well, the indifference, to say the least of it, that was shown to the West Indies, resulted, as was natural, in their decline. Though they had been extremely prosperous, and though at a time when this country was in a financial difficulty, a magnificent contribution was made by the West Indian Colonies to the public service (hear, hear), the time came when the West Indian industry languished, and when something much worse than the abolition of differential duties caused their industry to decline. When those duties were abolished the Bounty and the Cartel system had not been invented, but by degrees that system reduced the price that could be realised for cane sugar to such an extent that it could not be produced at a profit. Well, some of those who were interested in the West Indies resolved that if possible the consciences and sensibilities of their countrymen should be awakened, and that measures should be taken to redress this standing grievance, for what grievance could be greater than that by artificial means the produce of foreign countries should have been laid down—dumped down, as the slang of the day goes—on our shores, and that our oldest Colonies should languish and die. (Hear, hear.) Well, prominent among those who set to work to procure the reversal of this system was our friend and guest of this evening. (Cheers.) It is nearly forty years since Sir Nevile Lubbock first attended the West India Committee. He became vice-chairman in 1873, and, I think,

chairman in 1884, and during all these years his efforts have been assiduous and persevering to awaken the sense of the country to the injustice which was being done to our industry by this Bounty system, and to procure measures for its redress. Well, I am glad to say that at last his efforts have been successful. (Cheers.) He has procured the formation of the largest deputation of members of Parliament to wait upon a Minister; and the responsible Ministers at last, altering the policy that had for some years been blindly pursued, combining with the other nations of Europe, produced the result of a Conference which I hope is to put an end for ever to this iniquitous system (hear, hear), iniquitous, I mean, for us to acquiesce in; natural enough for those whose object it is to push their own industry.

But Sir Nevile Lubbock's efforts and services have not been confined to his public action. He has been prominent in pushing the most important industry in the West Indies. He instituted in Trinidad the system of central factories and also of cane farming which attained such great development. (Hear, hear.) Now I have been told, to show the rapid development of this industry, that in the year 1879, one thousand, three hundred tons of farmers' canes were turned into sugar at the Usine St. Madeleine, and that this year 160,500 tons of farmers' canes have been worked in the Colony. (Cheers.) And this is no rich man's business, but it is a popular business, for there are 4,443 East Indian and 4,440 West Indian cane farmers. I had an opportunity two years ago of visiting the Usine St. Madeleine, and it really was a magnificent sight, for there were 7,000 acres of cane, I was told, in sugar, and there were sixty miles and upwards of steam tramways running through the estate and bringing the sugar to the factory; a beautiful and it seemed to me a speedy means of gathering it up and treating it. I said to the manager, "They tell me that the machinery in this country is inadequate, but it seems to me that this is very modern and well developed." "It is absolutely obsolete," he said. (Laughter.) But then the Americans are famous for throwing their machinery into the scrap heap and having new about every five years. However, it was sad to think that the sugar produced at such an expenditure of capital, and it seemed to me so skilfully, should be produced at a loss, as indeed it was the fact, and we know had it not been for the change of the law it would have been no longer possible to continue the industry. Now, I say it is greatly owing to my friend on my right that this great change in public opinion has been brought about (cheers); that Great Britain took a leading position at the Conference which has brought an end to the Sugar Bounties (hear, hear); and that legislation has been passed which shall avail to apply the proper punishment if again our industries should be attacked here by the importation of sugar by such combinations as we have had to complain of. Now, I am glad that the West India Committee have not only been honoured in the person of their Chairman by the favour of the Crown, but that the Deputy-Chairman of the Committee has been included in the list of honours conferred on His Majesty's birthday. I am sure the Committee are proud that Sir Henry Davson should have been so honoured on that occasion. (Cheers.)

I congratulate you on the occasion on which we are met, and I am proud indeed to have been in the chair when one who has done so much for the

West Indies is being honoured in the presence of my friend (cheers), but as we say in the House of Commons, I shall conclude with a motion, that is to say, a toast, but in the first place I shall ask Sir Henry Davson to make a presentation.

Sir Henry Davson: Sir James Fergusson, my Lords and Gentlemen, I make use of no mere figure of speech when I assure you that I feel it a very high privilege that it should have fallen to my lot to respond to the call of the Chairman. Firstly, however, I must thank him for the unexpected compliment he has been good enough to pay me personally. I assure you that I highly prize the very great honour that has been conferred upon me by our gracious King, and I esteem it a very great compliment that Sir James Fergusson should have alluded to it in the way he has done, and that his remarks should have been so cordially responded to by all present here to-night. (Cheers.) . . . .

It is impossible for me, sir, in a short speech to recapitulate all that Sir Nevile Lubbock has done for the West Indies and British Guiana. What he has done publicly has already been referred to by the Chairman in more eloquent language than I can employ. What he has done privately, and it has been by far the most arduous part of his work, is only known to those who have had the opportunity of working with him behind the curtain. (Cheers.) I shall therefore confine myself at the risk of repetition, for the Chairman has already referred to it, to the crowning success of his labours, when he led our campaign against the Sugar Bounties. (Hear, hear.) For a quarter of a century had the West Indies to contend against the heavy handicap which had been placed upon them by the bounties of foreign states, legitimately established in the first instance to protect and foster a new industry of their own; unfairly maintained in later days with the avowed object of annihilating the sugar-producing colonies of this country by ousting them from that great dumping ground of the world, known on the map as Great Britain, known to us as something more; known to us as our own Motherland. (Cheers.) So great was the struggle that we had to maintain, that at last it seemed to some of us that the hope which had inspired us throughout was no longer deferred, but dead. During the whole of that intense anxiety, an anxiety bordering on despair, it was Sir Nevile Lubbock's voice that cheered us, it was Sir Nevile Lubbock's skill and experience and indomitable pluck that led us on until the Conference at Brussels. (Cheers.) The details of what transpired at that Conference are unknown to us, but this we do know, we know that Sir Nevile Lubbock was there as the expert adviser of the British delegates on behalf of the West Indies, accompanied by his able and trusted colleague, who represented another interest, Mr. George Martineau. (Cheers.) We know also that the result of the Conference was the signing of a convention, and that convention gave us all that we ever fought for, all that we ever asked for, free trade in sugar. (Cheers.)

Sir Nevile Lubbock, it now devolves on me to present you the offering of those who have combined to do you honour. The combination consists, not only of West India proprietors, but of bankers, merchants, ship owners, brokers, engineers, cane farmers, and of all others who are interested in the welfare of the West Indies. (Cheers.) Allow me in the first place, sir, to

present you with a life-like portrait of yourself, executed by the greatest portrait painter of the day, Professor von Herkomer. (Cheers.) Beneath the portrait is a tablet recording the occasion and the eminent services you have contributed to the West Indies. Allow me in the next place to present you with the silver centre-pieces and candelabra that accompany it, the handiwork of a master of his craft. Long, Sir Nevile, may you live to enjoy the possession of these well earned trophies, until in the ordinary course of life they are handed down, along with your own good name, to your posterity. (Cheers.)

Sir H. Davson then made some suitable reference to the part Lady Lubbock had played in aiding her husband in his work, and begged Sir Nevile to accept the diamond tiara for presentation to her as a token of respectful esteem on the part of the Committee.

Sir Nevile Lubbock, who on rising to respond was greeted with loud and prolonged cheers, said:—

Sir James Fergusson, Sir Henry Davson, my Lord Duke, my Lord, and gentlemen, I have in the first place to thank you, Sir James, for the very kind manner in which you have proposed the toast of my health, and to thank you all, gentlemen, for the very cordial manner in which you have received the toast. Sir Henry Davson, I have to thank you most warmly for the exceedingly kind manner in which you have, on behalf of my West Indian friends, made me the presentation of this magnificent testimonial which they have been good enough to give me to-night. If anything could add to the value of the testimonial in my eyes it would be the very kind things you have said of me, particularly coming, as they have done, from an old friend and a colleague such as yourself. Then, gentlemen, to you all, and to my West Indian friends, I really do not know how to express my great appreciation of your kindness and the great honour you have done me in presenting me with this handsome testimonial to-night. I can assure you that it will always be most highly valued by myself and my family. With regard to the picture, you can understand that it will be highly appreciated, perhaps not so much because it is an excellent portrait of myself, perhaps not so much because it is a great work of art, but I think the more because it is an evidence of all the kindness I have so long experienced at your hands. (Cheers.) Gentlemen, not only do I thank you for your kindness in presenting me with the picture, but I can assure you that it has been very great pleasure for me to sit for that picture to so eminent an artist as Professor von Herkomer. (Cheers.) . . . . .

Now, gentlemen, not content with presenting me with this portrait, you have been good enough to present me with this very handsome service of plate. I need hardly say I shall never see that plate upon my dinner table without being reminded of all your kindness, and of the long and anxious hours which we have all gone through together. Then lastly, gentlemen, I am indeed touched by your kindness in thinking of my wife. On her behalf, as well as my own, I beg to thank you for the present you have made to her.

Gentlemen, this is an occasion on which we are met to celebrate the abolition of the bounties (cheers), and I think, therefore, that it is only fitting that we should remember some of those who have helped us in fighting the great fight in which we have been engaged for so many years. The first name of course that will occur to you all is that of Mr. Chamberlain. (Loud cheers.) Gentlemen, you all know how much we owe to Mr. Chamberlain in this particular matter, but we West Indians also are aware that we owe a great deal to Mr. Chamberlain in regard to his policy towards the West Indies beyond the mere fact of the Sugar Bounties. I think that after Mr. Chamberlain came to be Secretary of State for the Colonies, we very soon realised that in spite of the large amount of his time and attention that was necessarily taken up by more important colonies, and particularly by the South African colonies, because even then it was evident that trouble was brewing, we very soon realised that Mr. Chamberlain had no intention of losing sight of the West Indies. (Hear, hear.) I think we very soon satisfied Mr. Chamberlain that all was not well with us. He thereupon set to work to see what he could do, and the first thing he did was to appoint a Royal Commission to go out and visit the West Indies and report to him specially upon the sugar question, and upon any other questions which might have a bearing upon the welfare of the West Indies. As you all know, the Chairman of that Commission was our friend Sir Henry Norman. (Cheers.) Gentlemen, you know what the result of that Commission was. I believe that the result of it was that our Government decided that they would call together a Conference on the Sugar Bounty question. But it appeared that Belgium had already been making overtures for a Convention, and therefore our Government left the matter in the hands of Belgium, and Belgium convened the first Brussels Conference. I say the first, although there was only one theoretically, but actually there were two. Well, I think you all know that at the Conference nothing was done; everything fell through because our Government was a little wanting in backbone. (Hear, hear.) Then, after that Conference, Bounties became worse than ever. Cartels came into force, and within about two years the West Indies, I may say, vulgarly speaking, were knocked into a cocked hat. But not only the West Indies, but every other sugar producing country, with two exceptions, were in the same position. The only two countries which were not affected were Austria and Germany. They could compete at £3 a ton below cost of production and still have a fair profit. Other countries which had not got Bounties or not such large Bounties, were not in a position to do that. Therefore Java, the West Indies, and Cuba, and all the large sugar producing countries were on their beam ends. Then the Government hardened their hearts. The second Brussels Conference met. Our Government put their foot down, and said unless something was done they would take the matter into their own hands. The thing was done. That was about the twentieth Conference, I think. Mr. Martineau will know that we had some twenty Conferences, but that all failed because our Government would not say the word. At that Conference they said the word and the thing was done, and from the 1st September last, the Bounties have been abolished. (Cheers.) Now, gentlemen, what I want to impress upon you is that we have got to thank Mr. Chamberlain for that. (Renewed cheers.)

I have alluded to the Royal Commission which Mr. Chamberlain sent out to the West Indies, and I have mentioned as you all know that our friend Sir Henry Norman was the Chairman of that Commission. Now, gentlemen, we all know what Royal Commissions usually mean. They usually mean that when the Government has got rather an awkward matter that they want to shelve they hand it over to a Royal Commission, and most Royal Commissioners think they have done their duty by their country when they have compiled a report in which they make the evidence put before them chime in with the theories of the parties to which they belong. But that was not the case of the West Indian Commission. Sir Henry Norman went out to the West Indies, and he took the greatest pains to ascertain what were the facts of the case, and he had the honesty and courage to report truthfully when he came back upon those facts. I think we are much indebted to Sir Henry Norman for what he did on that Commission. (Cheers.)

Then we have three gentlemen here to-night who were our delegates at the Brussels Conference—Sir Henry Bergne, Mr. Pearson and Mr. Pittar. I very deeply regret that we have not a fourth—Mr. Ozanne. I received a very kind letter from him expressing his great regret that he could not attend here to-night, as he was detained in Guernsey on business and could not possibly get away. But our thanks are due to Sir Henry Bergne, Mr. Pearson and Mr. Pittar for the good work that they did for us at Brussels. (Cheers.) I was there during the whole of the time. I was present at all the Conferences, therefore I can speak with some knowledge when I say I think we are all very much indebted to those three gentlemen. I am very glad to add that Sir Henry Bergne and Mr. Pearson are still our delegates on the permanent Commission at Brussels, whose duty it is to see that the Convention is carried out. I need only say that I am perfectly satisfied that our interests are quite safe in their hands. (Cheers.)

Then, gentlemen, there are a good many Members of Parliament whom we have to thank for their kindness in assisting us in many ways. I may allude to our Chairman to-night, Sir James Fergusson, who has always been ready to assist us. (Cheers.) I should like to mention Mr. Lawrence, who, as you know, has acted as Chairman of several Members of Parliament who were good enough to form themselves into a Committee to watch our question. I refer to Colonel Denny, Mr. James Reid, Mr. A. Wylie, Mr. C. Mc.Arthur, and Mr. D. V. McIver. They appointed Mr. Lawrence as their Chairman, and I think we are very much indebted to them. I should also like to mention the name of Sir Cuthbert Quilter. And there is one other name I wish to mention. Those of you who understand what was passing in Parliament will understand who I mean—I mean Colonel Milward. Colonel Milward took a great deal of trouble for us, and I am sure we must deeply regret that he did not live to see the result of his work.

Then, gentlemen, we must not forget the House of Lords. It still exists—(laughter)—and we have here not only Lord Stanmore, to whom I have alluded, but also the Duke of Marlborough; in the first place we all wish to thank him for his presence to-night, but in the second place we all

wish to thank him for the very able speech which he made in the House of Lords on our question. (Cheers.) There is one other gentleman that I should like to allude to. He is not an Englishman, but he has done us very great service on this question; I allude to M. Yves Guyot. M. Yves Guyot did not approach this question from an English point of view; he approached it from a French point of view. It appeared to him to be a monstrous thing that the French taxpayers should be contributing £4,000,000 sterling a year to the French Exchequer, the great bulk of which went into the pockets of some 200 or 300 *fabricants* in the northern districts. M. Yves Guyot assisted the French Government I believe materially in awakening public feeling in France. As you all know, he is a most able writer, and by the publication of articles he did rouse such an amount of feeling in France as enabled the Government to deal with the question and put an end to their Bounties. I was a little behind the scenes at that time, and therefore I know a great deal more than you can possibly do of the good work M. Yves Guyot did. Not content with his writings, he exercised his influence over the French Government; he visited most of the European capitals to smooth down little difficulties which arose here and there, and he did so with great success. Not only are we exceedingly pleased to see him to-night, but for my own part I beg to thank him most cordially for the great trouble he has taken to come over from Paris to attend this dinner. (Cheers.)

Then, gentlemen, amongst our own body there are a few names I should like to mention. It is impossible to mention everybody, so many have done good work and good service, but first of all I should like to mention Sir Henry Davson, who as we all know helped us materially. Then there is Mr. Foster M. Alleyne, who 20 years ago was our Treasurer, and Mr. Shepheard. (Hear, hear.) With regard to Mr. Shepheard, I should like to say this—I think that Mr. Shepheard deserves the credit of having been the first to explain what the legal interpretation of a favoured-nation-clause was as bearing upon the question of Bounty. We all know that Mr. Shepheard wrote an opinion on that question. I think it was some 20 years ago. That opinion was signed by Mr. Sheldon Amos and by himself. At that time the Law Officers of the Crown did not share that opinion as being sound, but they have since done so, and what is more important still I think we may say that all the European Governments have accepted that opinion as sound, and I say that for this reason that countervailing duties have been in existence in the United States for some years, and have been in existence in India for at any rate the last two years, and although the question has been raised it has never been very seriously pressed by any European Government, so I think Mr. Shepheard deserves the credit of having been the first to put the proper legal interpretation upon the most-favoured-nation clause, and I am sure he deserves every credit for it. (Cheers.)

There are some other gentlemen whose names I must mention; Mr. Czarnikow, who I very much regret cannot be here to-night owing to a very severe cold, Mr. Edwin Tate, and Mr. L. A. Martin, who with the other refiners have worked with us so loyally, our staunch old friend Mr. Kynaston, and Mr. Beeton, the energetic secretary of the Anti-Bounty League.

And now, gentlemen, we come to a very old friend of ours. You all know when you go to the opera the "primo tenore" is put at the bottom in large type at the end of the list of performers. I have kept our "primo tenore" for the last. It is our friend Mr. George Martineau. You all know how much we owe to him. For some thirty years or more he has been incessantly writing pamphlets, letters to the papers, attending conferences, and more than that he is, I believe, the only man in this country who has kept himself really absolutely in touch with all the numerous and complicated phases which the bounties in each country have been going through during that time. Gentlemen, I think we owe a great deal to Mr. Martineau, and for my own part I cannot help thinking sometimes that the little stone which Mr. Martineau and I set rolling thirty years ago has become the head stone of the corner. I constantly see the Sugar Bounty abolition being alluded to as now a matter upon which there can hardly be any difference of opinion, but that is a very late idea that has come over different statesmen. I am very glad it has come to them at last, but we have had a long fight to bring it home to their minds, and I think you owe it very much to Mr. Martineau that we have succeeded in doing so. (Cheers.)

Now, gentlemen, I have dealt a long time with our friends, and by rights I ought to say something about our opponents. I wish to be very short, but I may say that I noticed the other day a small but mysterious communication in *The Times*. It was not very clear what was intended, but I read it to mean that there was some danger of bounty-fed jam coming into this country, and the attention of the public was called to the fact that Mr. Balfour had undertaken in the event of bounty-fed jam coming to this country that steps must at once be taken to put a stop to the importation. I do not wish to say anything about that. It was very amusing to me to find these gentlemen, who were so strongly in favour of bounty-fed sugar because it made it cheaper to the consumer, when it comes to bounty-fed jam are of a very different opinion. (Laughter.)

Sir N. Lubbock brought his long and interesting speech to a close with references to the fruit and cotton industries in the West Indies, to the important part played by the Imperial Department of Agriculture, and to the work of Prof. J. B. Harrison. He also referred to the excellent relations existing between the Committee and the West Indian Department at the Colonial office.

(*To be continued.*)

A STUDY IN RAFFINOSE DETERMINATIONS.

By David L. Davoll, Junr.

The existence of several methods for the determination of raffinose in the presence of saccharose, together with variable results obtained in the application of the same to the analysis of the same product, have impelled me to investigate the matter more closely after the close of the "campaign." As the result of a study of the various methods, I have been led to combine the best features of some of them and believe that I have succeeded in applying a slight modification to the method of Clerget, which will secure for it accurate and satisfactory results with dark coloured products. The modification proposed is that of applying powdered zinc after inversion and at the temperature of inversion, with the production of an almost colourless solution with no change in the products of the hydrolysis of either sucrose or raffinose.

As the basis of these experiments a pure, doubly refined, white sugar, of undoubted cane origin, was employed and a commercial sample of raffinose from the house of Kahlbaum. The cane sugar was perfectly free from invert sugar and polarised 99·97 per cent. pure after being powdered and dried at a temperature of 60°-70° C.

The one sample of molasses was employed throughout the work.

Three samples of animal charcoal were purchased from a reliable Chicago firm and in original packages as bottled by the German firms of Merck and Dr. König. These chars were dried to constant weight before use at a temperature between 115° and 125° C. It is important to know that the moisture content of these chars varied from 7·17 per cent. to 25·7 per cent.

The modern double-field S. and H. instrument employed was very recently checked by means of a quartz plate kindly loaned by the Division of Chemistry, U.S. Dept. of Agriculture, Washington, D.C., and all important points on the scale verified by a pure sugar standardized against the quartz of 90 per cent. polarisation. The levo-rotation, when checked against the dextro-rotation, gave the same figure in every instance. The flasks used were all restandardized to hold 100 Mohr cc. All polarisations, both direct and invert, were made in the same jacketed 200 mm. tube and at the standard temperatures of 17·5° C. (for direct) and 20° C. (for inverted) so as to avoid all corrections for variation in specific rotation. The readings as given are averages of at least five separate re-readings.

Some work by G. Reinhardt, calling attention to the often increased levo-rotation where char is used for decolorising "rest" molasses arising from strontium juices, has impelled me to apply the samples of char mentioned for the purpose of reviewing his findings. Reinhardt mentions that bone black has been regarded, up to the present time, as diminishing levo-rotation by absorption, while blood

char, in spite of its superior decolorising power, had to be given up because of high absorption.

Following are our results in determining the effect of char upon a solution of pure cane sugar after hydrolysis by the strict method of Clerget.

	Original polarisation.		Calculated normal basis.
(1) Carbo Sanguinis, acido depur. pro analyse. Dr. König	—16·41	..	—32·82
(2) Animal charcoal, Merck, highest purity, dry..	—16·29	..	—32·58
(3) Animal charcoal, Merck, reagent	—16·21	..	—32·42

I have not found the levo-rotation diminished by Carbo Sanguinis, but rather slightly increased. Three grams of all chars were used and the vigorous shaking continued five minutes, with three minutes allowed for filtration. Reinhardt found slight diminution, increasing with blood char.

Dr. G. Wiske* has elaborated Reinhardt's investigation, working also with dextrose, levulose and galactose in their separate behaviour towards chars. Differing with Reinhardt, he finds absolutely no absorption or change when char is applied five minutes to inverted pure sucrose. He explains this invariability by showing in a test with equivalent quantities of levulose and dextrose that the notable absorption of dextrose, together with small absorption of levulose, mutually counteract any error. Where raffinose is present the results are different.

Reinhardt has shown that with rising raffinose content there is increased levo-rotation. In the case of bright after-products having 2·5 per cent. raffinose and using 3 grams of "Klaerkohle" he found the same levo-rotation. He explains this by saying that the absorptive power which diminishes the levo-rotation in the case of inverted pure saccharose is compensated by the simultaneous increase in levo-rotation of inverted raffinose; also due to absorption; hence, where 2·5 per cent. raffinose is present the results are correct, while with less than 2·5 per cent. too little saccharose and too much raffinose is found, though the error is small, while with more than 2·5 per cent. raffinose, too much saccharose and too little raffinose is found. Reinhardt further considers that high levo-rotation is due to absorption of dextro-rotatory melibiose, but he awaits further investigation.

Wiske has also imitated a mixture of raffinose and saccharose by inverting and polarising a mixture of saccharose, levulose and melibiose, finding a very strong increase in levo-rotation with use of char. In experiments upon mixtures of saccharose and raffinose as they occur in after-product masse-cuites, sugars and "rest" molasses, he finds the degree of absorption to be entirely dependent upon the quantity of raffinose and indifferent to the quantity of saccharose. Employing half-normal and three grams char, he recommends a

* See *I. S. J.* 1903, p. 37.

subtractive correction of one-tenth degree for every per cent. of raffinose above two per cent.

To ascertain the comparative effect of the three varieties of char upon hydrolyzed mixtures of pure cane sugar and raffinose, 12·367 grams cane sugar and 0·657 gram raffinose were hydrolyzed in 75 cc. dilution, according to the strict Clerget method, shaking five minutes with three grams char and filtering two to three minutes. The direct polarisation of a normal solution of such a mixture was 102·48 per cent.

	Original polarisation.	Calculated. normal.	Raffinose.	Sucrose.
Polarisation without char	—13·50	—27·00	4·16	94·77
(1) Carbo Sanguinis, acido depur. pro analyse. Dr. König	—13·57	—27·14	4·11	94·87
(2) Animal charcoal, Merck, highest purity, dry	—13·70	—27·40	3·95	95·16
(3) Animal charcoal, Merck, reagent.	—14·00	—28·00	3·56	95·89

The samples of blood char, under the conditions, produced a levo-rotation that results in a raffinose content not far removed from polarisation without char, which may be explained by the absorption of dextro and levo-rotatory substances, mutually offsetting each other.

A notable increase in levo-rotation will be shown later in further comparative tests.

The effect of time as a factor in decolorising, is shown where Merck's highest purity char is used upon the molasses:—

	Time of char digestion. Minutes.	Filtration. Minutes.	Original polarisation.	Calculated normal.	Raffinose.	Sucrose.
(1)	5	7	—5·48	—10·96	3·58	43·97
(2)	10	9	—5·51	—11·02	3·54	44·04
(3)	15	9	—5·55	—11·10	3·49	44·13
(4) Decoloration by zinc			—5·48	—10·96	3·58	43·97

The decoloration after fifteen minutes, while slightly more than that of five minutes, was not worthy of consideration. The result in (4) is that obtained by the action of one gram powdered zinc for three to four minutes at 69° C. after completion of inversion by the strict method of Clerget and is the modification I would propose as a solution of the vexatious problem of bleaching. It is added here for the sake of comparison and will be referred to later. The direct polarisation of this molasses was 50·6 per cent., using lead *-b-* acetate as a precipitant, with and without acetic acidulation, producing identical results in polarisation.

The method of Lindet as modified by Courtonne was examined, but gave such widely varying results with a mixture of pure cane sugar and raffinose that the results obtained upon a low product, like molasses, may by credited with difficulty. The method is as follows: 20 cc. of a solution containing one-fifth normal of the substance is placed in a 50 cc. flask, and five grams of zinc dust, accurately weighed, are placed in the flask. Heat the flask and contents by

immersing in boiling water. Add 10 cc. of dilute hydrochloric acid in portions of about 2 cc. at a time and as frequently as convenient. Prepare the dilute acid by adding to pure hydrochloric acid (sp. gr. 1·2) an equal volume of distilled water. Heat a few minutes after the last addition of acid. The undecomposed zinc occupies a volume of 0·5 cc.; hence, the normal invert reading is obtained by multiplying by 2·475. After the inversion is completed, cool the solution, either quickly or slowly, by setting aside. Complete the volume at 20° C. Mix, filter and polarise at 20° C.

In his original article, Lindet directs that 5 cc. concentrated hydrochloric acid be gradually added in four or five parts at intervals of five minutes, and that the zinc be filtered off before dilution to 50 cc. A formula is given for use with the Laurent instrument. Spencer* gives a formula for use with the S. and H. instrument as follows:

$$(1)\ \text{Sucrose} = \frac{C - 0{\cdot}493\ A}{0{\cdot}827} \qquad (2)\ \text{Raffinose} = \frac{A - \text{Sucrose}}{1{\cdot}85}$$

where A = the direct reading, and C = algebraic sum of direct and invert reading.

For convenience, all calculations based upon formulas (1) and (2) will be designated "Lindet" merely to distinguish them from Herzfeld's.

Results obtained by the Lindet-Courtonne method upon a mixture consisting of 4·9468 grams cane sugar and 0·2628 gram raffinose (total = $\frac{1}{5}$ normal) in 20 cc. distilled water, were as follows:

Original invert reading.	Result on normal.	Raffinose. (Lindet.)	Raffinose. (Herzfeld.)	Saccharose. (Lindet.)	Saccharose. (Herzfeld.)	
—10·07	—25·18	4·97	5·33	93·28	92·60	2 cc. dilute hydrochloric acid added every four to five minutes and heated five minutes additional; zinc filtered out.
—9·25	—22·89	6·47	6·81	90·51	89·87	The above repeated, but the zinc *not* filtered out.
—7·00	—17·32	10·05	10·40	83·89	83·23	Whole 10 cc. hydrochloric acid added within three minutes, and heat applied twenty minutes in all; zinc *not* filtered out.
Result by Clerget method		3·78	4·16	95·48	94·77	(For purpose of comparison.)

These results show that the method is totally unreliable with products of the above composition.

The Lindet-Courtonne method was then applied to the molasses having a direct polarisation of 50·6 per cent. and which by Clerget's method, using three grams char and shaking five minutes, gave 3·58 per cent. raffinose and by the decolorisation with one gram zinc, as is proposed, also 3·58 per cent. raffinose.

* Spencer: "Handbook for Chemists of Beet Sugar Houses and Seed Culture Farms," 1897.

Original invert reading.	Result on normal.	Raffinose. (Lindet.)	(Herzfeld.)	Saccharose. (Lindet.)	(Herzfeld.)	
—4·18 ..	—10·45 ..	3·76 ..	3·91 ..	43·65 ..	43·36	Adding hydrochloric acid every five minutes; total heating, twenty-five minutes; cooling quickly and filtering out zinc.
—4·35 ..	—10·77 ..	3·55 ..	3·70 ..	44·04 ..	43·74	Adding hydrochloric acid every four minutes; total heating, twenty-one minutes; cooling quickly zinc *not* filtered out.

The inversion even on "rest" molasses varies with varying conditions of time, &c. The results, besides varying beyond limits of error among themselves, vary also from the results obtained by the standard method, as shown above, where chars are compared upon molasses.

Perhaps the most instructive result is that shown in the following experiment, where are compared: (1) The strict Clerget method without char; (2) the strict Clerget method with three grams of Merck's highest purity char after five minutes' shaking; (3) the Lindet-Courtonne method, adding 2 cc. hydrochloric acid every four minutes and heating thirty minutes in all; (4) the Herles method, using 10·6 cc. lead nitrate solution and one-half equivalent sodium hydroxide; (5) the proposed modification to the strict Clerget method, *i.e.*, addition of one gram powdered zinc. Each 100 cc. of original solution contained 11·4612 grams pure cane sugar and 0·814 gram raffinose. It was the intention to secure the same polarisation as obtains in ordinary "rest" molasses with a content of 2·5 per cent. raffinose. With the exception of the Lindet-Courtonne method, 50 cc. of the original solution were taken for inversion. With the Lindet-Courtonne method, the prescribed 20 cc. were used in a 50 cc. flask and the zinc volume allowed for.

	Original invert reading.	Results of normal.	Direct polarisation.	Raffinose. (Lindet.)	(Herzfeld.)	Saccharose. (Lindet.)	(Herzfeld.)	
(1)	—5·87 ..	—11·74 ..	48·60 ..	— ..	2·65 ..	— ..	43·70	Strict Clerget
2)	—6·39 ..	—12·78 ..	48·60 ..	— ..	2·00 ..	— ..	44·91	Strict Clerget with char.
(3)	—4·52 ..	—11·19 ..	48·60 ..	2·86 ..	3·01 ..	43·32 ..	43·02	Lindet-Courtonne.
(4)	—5·97 ..	—11·94 ..	47·47 ..	— ..	2·30 ..	— ..	43·22	Herles.
(5)	—5·86 ..	—11·72 ..	48·60 ..	— ..	2·67 ..	— ..	43·65	Proposed method.

With the strict Clerget method and use of char the increased levo-rotation is very considerable and causes a very notable variation in sucrose and raffinose from the truth. The Lindet-Courtonne method, while not showing such great variation, is still unsatisfactory and does not inspire confidence; furthermore, the writer finds inversion under its conditions more time-consuming than under any other. The modification to Clerget's method that I propose seems to give results concurring with the strict Clerget method, both here and with molasses; also in a later experiment, where the proportion of raffinose is increased.

The method next inquired into is that of Herles,* with the object of ascertaining its action where raffinose is present. No comparison was made of it upon inverted pure cane sugar solutions.

Herles' chief objection to determinations by inversion as carried out up to that time was, that clarification by means of lead acetate for direct polarisation and not for invert, would give wrong results, because optically active substances are precipitated in the operation for direct polarisation, which remain in the inverted solution and either retain their whole optical activity or the acid changes it, or perhaps the optical activity is for the first time developed during inversion.

Degener has shown that invert sugar by evaporation, even *in vacuo*, loses its theoretical levo-rotation and finally becomes dextro-rotatory, which, by treatment with hydrochloric acid, according to Clerget, soon takes on its original levo-rotation; hence, it affects only the invert reading.

Herles states that lead nitrate remaining in excess as such has only insignificant action, and Herzfeld admits that the action is small. Herzfeld states that sodium nitrate heightens the polarisation and, while admitting that basic lead nitrate is a remarkable decoloriser, affirms that it carries down sugar with it, especially if the alkali be added all at once, and even a little if it be added drop-wise. Neutral salts, with the exception of the acetates, increase the levo-rotation, but the acetates reduce the free hydrochloric acid and thus lower inverting or hydrolysing power; hence, Herles was led to consider $PbOHNO_3$ as the most suitable form. He used "a lead nitrate solution of 1·3856 specific gravity (or about saturated), and in which 1 cc. = 0·3102 lead." This could not be correct, since a stronger solution of lead nitrate, *i.e.*, specific gravity 1·414, and containing 35 per cent. lead nitrate only contains the equivalent of 0·3094 gram lead.

He distinctly states that the solution should not be alkaline, as lead saccharate would be precipitated and, while proving that resulting potassium nitrate causes increased levo-rotation, belittles it by adding that the solutions are always weak in sugar where much potassium nitrate is formed.

The solution of lead nitrate used for this experiment had a specific gravity of 1·33233 and contained the equivalent of 0·2488 gram lead or 0·398 gram lead nitrate, equaling 29·872 per cent. Accordingly, 1 cc. of this lead nitrate, to form the stipulated basic salt, will require 1·202 cc. normal sodium hydroxide, or where the standard alkali has a corrective factor of 1·061 as in this instance, 1·133 cc. A normal of molasses was weighed out, and after dilution to about 70 cc. the specified quantities of lead nitrate solution added, and then the alkali solution gradually and with rotation of flask, when all was carefully

* Herles, 1890: "Ueber die Bestimmung des Zuckers durch die Inversionsmethode," *Ztschr. d. Ver. für d. Rübenzuckerind. d. deutsch. Reiches*, p. 217.

diluted to exactly 100 cc. at 17·5° C. 10·6 cc. lead solution and 12 cc. alkali solution cleared the solution perfectly and left no excess of alkali.

	$Pb(NO_3)_2$ solution. cc.	NaOH solution. cc.	Direct reading.	Invert reading.	Raffinose.	Saccharose.
(1)	9·00	12	50·75	—5·86	3·77	43·77
(2)	10·60	12	51·10	—5·86	3·85	43·98
(3)	12·00	12	50·99	—5·86	3·82	43·92

In samples (2) and (3), considerable lead chloride was thrown down. In such work of Herles as has come under our notice, the absence of very specific directions as to the limits of lead to be used, has left us without much information, and an intimate study of the best conditions is not warranted, as the process has the serious defects already referred to.

The direct polarisation on the same sample varies quite a little from that where lead basic acetate is used (*i.e.*, 50·6 per cent. pol.) which may be accounted for by the action of the lead salt upon the invert sugar present, which is a trifle less than two per cent. In the former table, where the five methods are compared, we have shown a reduction from 48·6 to 47·47 per cent. polarisation where basic lead nitrate was used; hence, this is probably more than compensated for by the modified levulose rotation. To recapitulate, the results obtained so far by the different methods upon molasses, we have:

	Raffinose.	Saccharose.	
Strict Clerget, with char	3·58	43·97	
Proposed method, adding zinc	3·58	43·97	
Lindet-Courtonne, varying conditions	3·91	43·36	
with Herzfeld's formula	3·70	43·74	
Herles' method, applied	3·85	43·98	½ equivalent sodium hydroxide.

The next experiment shows (1) the absorbent effect of char upon the products of the hydrolysis of pure saccharose and pure raffinose when they are mixed in varying proportions; also (2) results by the proposed new zinc modification to the strict Clerget method, when compared with the strict Clerget method without the use of char.

Direct reading.	Invert reading. without char.	Invert reading. with char.		
25·62	—6·62	—7·01	Used 0·3285 gram raffinose and 6·1835 grams sugar.	
48·60	—5·87	—6·39		17·1917 grams sugar and 1·221 grams raffinose.
48·60	—5·87	..	Proposed zinc modification.	
53·40	—4·58	—5·57		17·1917 grams sugar and 2·442 grams raffinose.
53·40	—4·57	..	Proposed zinc modification.	

The zinc in the presence of the hot hydrochloric acid at 69° C. has, therefore, absolutely no effect upon the products of the hydrolysis of saccharose and raffinose. It has been found advisable to filter out, by means of a very small tuft of cotton, the residue from the one gram of zinc left after cooling to 20° C., with quantitative washing of course, since the continued, slow evolution of hydrogen may disturb proper dilution to the mark.

The author wishes to add some tests made upon the correctness of Herzfeld's formula for the temperature correction for raffinose:

As Applied to Hydrolysed Half-normal Cane Sugar in 100 cc. Dilution.

Temperature. °C.	Original reading.	Calculated at 20° C. normal inversion.
17·2	—17·06	—32·59
20·0	—16·32	—32·64
20·9	—16·07	—32·59
21·6	—15·93	—32·66

As Applied to Mixture of 12·367 Grams Cane Sugar and 0·657 Gram Raffinose in 100 cc. Dilution.

Temperature. °C.	Original reading.	Calculated at 20° C. normal inversion.
16·4	—14·40	—27·00
20·0	—13·50	—27·00
23·0	—12·78	—26·97

It is not advisable to make the polarisation at any temperature without the use of the jacketed tube.

THE "PERFECT" SAND FILTER.

The "Perfect" Sand Filter, of which the Breitfeld-Daněk Engineering Co., Prague, are the patentees and manufacturers, has been specially designed for treating and filtering thick sugar solutions and syrups. There has hitherto been much difficulty in filtering such thick solutions, but the makers claim that their filter successfully copes with this difficulty and gives a perfectly bright and sparkling filtrate. The advantages claimed for this apparatus include the following:—

1. The filter can treat the very lowest molasses, of a great density (40 to 43 Bé) at a temperature of 194 degrees Fahrenheit.

2. The filtration takes place under a pressure of about 9 in.

3. As filter medium either sand, small coke, or slack can be used, the best results are however obtained with a sharp small grain river sand.

4. The working expenses are practically nil. They consist only in the washing of the sand. The loss of sand is not appreciable, only a very minute quantity being lost. It can be seen, therefore, that the expensive filter bags and filter sheaths which are used very extensively in cane sugar refineries are saved.

5. The liquor which is to be filtered runs through the sand from the top to the bottom under low pressure. By that means no canals are formed in the filtering medium by which the liquor can escape unfiltered.

6. By this method of working nearly all impurities contained in a turbid liquor are removed and are collected in the upper portion of

the sand surface. As the sand filter is only covered by a light sheet iron lid, the scum on the surface may easily be removed without stopping the working of the filter; consequently the apparatus can be worked for a lengthened period without the quality of the liquor suffering, and only bright and sparkling liquids are obtained.

7. The liquid which is under treatment and which is still above the sand can be drained off before cleaning the filter, so that it is only the small quantity contained in the medium itself which must be got rid of when cleaning.

8. If molasses are treated in this filter before entering the osmose-apparatus, there is a great saving of paper.

9. The sand is washed automatically by means of injectors, either in the filter itself or in specially arranged vats fitted with injectors; and is afterwards transported from the filter to the washing vessel or vice versa by means of injectors, so that all difficulties of transport are overcome.

10. One man alone can attend to a complete filtering plant and the expenses are therefore reduced to a minimum.

11. The filter does not require any foundation, and may be placed anywhere as desired. It also occupies only a very small space.

It must be pointed out that it is of the greatest importance to have the proper quality and grain of sand.

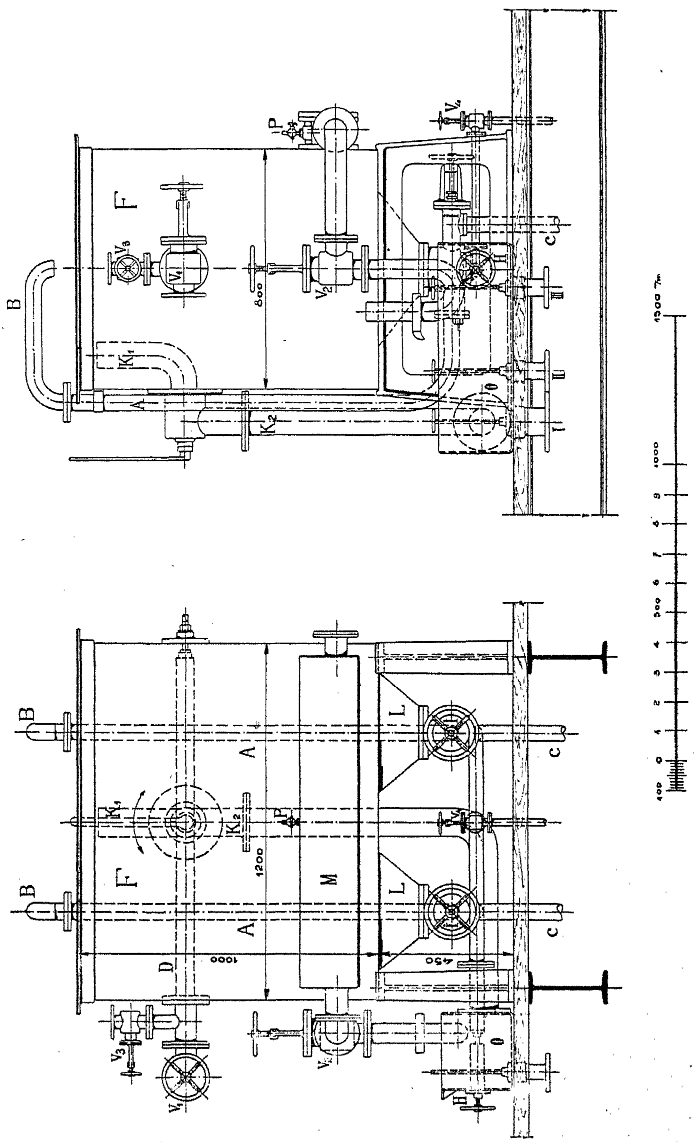
A few results of the practical working are here submitted.

1. In a Refinery.—The molasses from the fourth product, before going through the osmose-apparatus, were filtered. The temperature was 203° Fahr. and the density 41° Bé. In spite of the molasses having been of the worst possible quality the filter dealt with 6,000 to 8,000 kilos in 24 hours, the filtering being constant and satisfactory the whole time. By this is proved beyond a doubt that the sand filter is capable of filtering such dense and viscous fluids in a most satisfactory manner.

2. In a Raw Sugar Factory.—The off-running syrups from the first product were diluted to 30 to 31 Bé, at a temperature of from 176 to 194° Fahr. and were treated with milk of lime and saturated afterwards with sulphurous acid. 10,000 kilos (22,046 lbs.) were treated in 24 hours. The filtering took 18 to 20 hours, and was afterwards cleaned, the latter process taking 45 minutes and requiring 700 kilogrammes (1,550 lbs.) of water. The filter contained 900 kilos (2,000 lbs.) of sand.

The washing of the sand was done in the filter itself, by means of an injector, and was also accomplished in three-quarters of an hour.

3. In a Second Raw Sugar Factory.—Undiluted syrup of 38 Bé was treated at a temperature of 176 to 194° Fahr. without the addition of milk of lime or sulphurous acid. The filtering period was about the same as in the preceding case, but the result in 24 hours was somewhat less.


B
Γ
A
D
M
L
P
0
C
800
1200
1000
450
1500

The juice was then diluted to 31° Bé, and the results then coincided with those detailed above.

4. In a Cane Sugar Factory.—In the Cane Sugar Factory of Santanen-Lor (Java) one "Perfect" Danék and three filters of another system were at work. Defecated cane juice was treated with the best results on the "Danék" Perfect Filter.

Directions for Filtering and Washing.—The liquor to be filtered must be heated to at least 185° Fahr. and should it have a lower temperature than that, a special heater would be required to produce the required temperature. The filter is filled with sand up to the pipe *D*. The liquid to be filtered is admitted through the valve *V* and the pipe *D*. This pipe, which is situated in the inside of the filter, is split at its upper end, thus distributing the fluid over the whole length of the filter. The liquid should at first be admitted very slowly, so as not to disturb the surface of the sand. As soon as the level of the fluid above the sand has reached a height of $9\frac{3}{8}$ inches, the inlet valve must be so regulated as to allow the same amount of juice to enter the filter as that which flows out at the exit.

After the juice has passed the filtering medium under head pressure it is collected in the apartment *M*, and flows through the valve V_2 into the receiver *O*. This receiver is fitted with three outlets. The middle one for the purpose of letting off the cloudy filtrate when starting the filter; one of those at the side to let off the finished product and the mixture when washing the sand; and the second at the side for carrying off the poorer mixture when washing. The two outlets at the side are fitted with tubes for carrying saccharimeters.

When starting the filter it is necessary to partly close the valve V_2 until a clear liquor is obtained. The outflow becomes less and less after a time, and it is then advisable to open the valve V_2. As soon as the outflow becomes less in spite of the valve being fully open, it is a sign that the filter medium is stopped up with dirt. The dirt settles chiefly upon the surface of the filtering medium, and can then be drawn off with a scraper, thus leaving a clean surface for further work, without having to stop working or to wash the filter. It is advisable to somewhat close the valve V_2 and open air-cock *P* before removing the dirt, so that the apartment *M* be filled slowly with filtered juice. After removing the dirt the valve V_2 can be again opened, and the outlet can be regulated as before.

When the outflow becomes reduced again the valve V_1 is closed. The juice which is still above the filter medium is drained off through the movable knee, and hot water is admitted through the valve V_3 and the pipe *D* to wash the filter. During this process the valve V_2 is half closed, in order that the mixture of water and liquid under treatment may flow out in constant quantity and quality. At the beginning of this washing process the mixture coming from the filter and collecting in the receiving tank *O* is let off on the filtered fluid. Later, however,

the poorer mixture is led into a special cistern, where it is stored for diluting purposes.

The remainder of the fluid is then drawn off from the sand by means of the cock *H*, situated in the bottom of the filter, and is led from the trough *L* into the receiver. As soon as the washing of the filter is accomplished, the valves V_2 and V_3 are closed and steam is admitted to the sand trough the valve V_4, during which process the cock *H* may remain open. The cones *L L* can be blown through with steam by means of the valve V_5, after which the sand may be washed as described below.

Directions for the Washing of the Sand.—Open the injector valves *i i*, and admit hot water, either from a pump or an injector (the pressure should be at least 30 lbs. per square inch) through the pipe *C*. The hot water forces its way through the pipe *A B*, and flows through the sand from bottom to top, so that in that way the sand is thoroughly washed. The dirty water flows off through the knees K_1, K_2, into the receiver *N*, and is thence let flow to the drain. This receiver *N* is fitted with two out-flows, one connected to the drain to carry off dirty water, and the other to conduct unfiltered liquid back to the tank. As soon as the out-flowing water is clean the washing is finished, and the filter can again be prepared for work. The water remaining above the filter medium is drained off through the movable pipe K_1, and the sand surface is smoothed. The pipe *D* must be removed before washing the sand.

DRY DEFECATION IN OPTICAL SUGAR ANALYSIS.*

The analysis of raw sugars, which is of so much importance both from the commercial and technical sides, naturally has received the closest attention by chemists, and the International Commission for Uniform Methods of Sugar Analysis has done much to perfect the methods employed.

The errors involved in polariscopic determination of sucrose have been gradually eliminated and several battles royal have been waged by the advocates of different ideas in arriving at the truth.

Probably the most important error that remains, and which has defied many earnest attempts to overcome it, is due to the volume of the precipitate formed when clarifying the raw sugar solution with subacetate of lead to prepare it for observation in the polariscope.

A year ago the writer devised a method for obviating, in great part, this error and succeeded in adapting it to technical analysis of refinery samples. Last June Dr. Wiechmann presented an admirable paper to the Berlin Congress advocating the careful search for a method of

*Read at a meeting of the New York section of the *American Chemical Society*, December, 1903.

analysis which would overcome this error due to the volume of precipitate.

The writer has now developed his method so that it gives very good results with raw sugars.

Ordinarily, in preparing a sample of raw sugar for polarization, the normal weight of the sugar is dissolved in about 80 c.c. of water in a 100 c.c. flask, a little solution of subacetate of lead is added, sufficient to precipitate colouring matter and some other impurities, the whole made up with water to the 100 c.c. mark, shaken, filtered, and polarized.

The precipitate formed occupies a definite volume within the 100 c.c., thus forcing the sugar to be diffused through a volume of solution somewhat less than the 100 c.c. for which the polariscope is designed. This concentration of the sugar solution of course raises the polarization in proportion, and these incorrect polarizations are very objectionable both from the commercial and the manufacturing standpoints.

The writer's idea is to defecate the solution in such a way that after defecation the sugar shall remain dissolved in exactly 100 c.c. of solution, and that whatever precipitate there is may occupy space exterior to that solution.

In order to accomplish this the normal weight of sugar is dissolved in water in a 100 c.c. flask and made up to the mark without defecation. The concentration is thus at exactly the proper degree. It now remains to defecate the solution properly by precipitating the impurities in such a way as to produce the minimum change in the concentration of the solution of sucrose. This is accomplished by adding to the 100 c.c. of liquid small quantities of powdered anhydrous subacetate of lead until the impurities are nearly all precipitated. This point is as easily determined as in the defecation by a solution of the same salt. The organic and mineral acid radicals in the solution combine with and precipitate the lead and lead oxide of the dry salt, while the acetic acid radical of the subacetate of lead passes into solution to combine with the bases originally united to the other acid radicals. If the acetic acid occupies the same volume in solution as the acid radicals replaced by it there should be no change in the volume of the solution and no change in concentration of sucrose. If the acetic acid is of less volume than the acids replaced the volume of solution should be less after the addition of the lead subacetate, and this concentration of solution should increase the polarization. One would expect the acetic acid radicals to be lighter and smaller in volume than the more complex acid radical of the colouring matters and other impurities present. And in fact this supposition appears to be borne out for apparently there is a slight concentration of solution during the above described method. But a very long step has been taken in the right direction, because whereas in the usual procedure the error is proportional to the volume of the total precipitate, in this

dry defecation the error is only proportional to the difference in volume of acetic acid and the precipitable radicals involved. Means of eliminating this small residual error are under investigation.

In order to test the correctness of this theory various samples of typical raw sugars of different grades and from different countries have been subjected to comparative tests by the two methods and to the determination of their true polarizations corrected for the volume of precipitate.

The method of investigation is as follows: The sample of sugar is thoroughly well mixed and put into a glass jar closed by a glass cover and rubber gasket. The normal weight of this sample is introduced into a 100 c.c. flask and dissolved in about 80 c.c. of water. Then a solution of subacetate of lead of 25° Brix is carefully added from a burette until the impurities are nearly completely precipitated. The volume of lead solution used is noted and the flask is filled to the 100 c.c. mark with water, shaken, filtered and polarized. Now another normal weight of the same sample of sugar is dissolved in the same flask with water and the solution is made up to tho 100 c.c. mark with water. Then a weighed amount of anhydrous subacetate of lead, equal to the salt contained in the solution first used, is added, the whole shaken, filtered and polarized. This polarization may then be compared with the ordinary and with the true polarization, obtained by correcting the ordinary for the volume of precipitate. There are various methods for doing this, but the one involving the fewest observations and manipulations, and so the most correct, is a modification of Sachs' method. The lead precipitate obtained in the ordinary defecation is washed on the filter until free from sugar by the alpha-napthol test and then washed into a pyknometer, which is filled up with distilled water and weighed at standard temperature. The excess of this weight over that of the pyknometer full of water alone is equal to the excessive weight of the precipitate over the weight of an equal volume of water. The precipitate is now filtered upon a weighed filter, dried and weighed. The weight of the precipitate minus its excessive weight over an equal volume of water is of course equal to the weight of its own volume of water. Changing grams in the weight of the equal volume of water into c.c. we have the volume of the precipitate. From this one calculates the true polarization from the ordinary polarization by Sachs' formula which is essentially 1/100 of the observed polarization multiplied by 100 minus the volume of the precipitate in c.c.'s. This method is similar to that employed by Dr. Wiechmann except that he first dried the precipitate and afterwards determined the specific gravity in benzine and calculated its volume from the weight and the specific gravity. The specific gravities obtained by the writer vary from 1·96 to 3·20. The cause of the variations of specific gravities of precipitates is to be further investigated.

As it is practically impossible to read on the polariscopic scale more closely than to half a tenth or one tenth of a degree it follows that where the error in polarization due to the volume of precipitate amounts to only a tenth of a degree it is very difficult to draw correct conclusions from any single set of observations, but inferences drawn from averages are better; and where the variation is several tenths between the observed and the true polarizations one can feel a greater certainty in regard to results. The analytical results obtained on a dozen sugars of different grades and origins are given in the accompanying table, an examination of which will show that in high grade centrifugal sugars where the volume of the precipitate is equal to ·1 c.c. or less this method has overcome on the average more than half of the error, and in low grade sugars where the volume of the precipitate is ·3 c.c. to ·8 c.c. the dry defecation has overcome on the average over 84% of the error. Probably the dry lead method will be found to give as good results on the high grades as on the low grades when large numbers of tests are averaged. No single test on a very high sugar can be conclusive, as the errors of reading the polariscope are about as great in this case as the error we are striving to eliminate.

RESULTS OBTAINED BY DRY DEFECATION OF RAW SUGARS.

	Grade.	Country.	Pol.	Vol. ppt.	Corrected Pol.	Dry Pb. Pol.	Difference from Ord. Pol.	Difference from Cor. Pol.	Sp. Gr. of ppt.
1	Cent.		95·0	·10	94·9	94·9	–·1	0·0	2·98
2	Centr.	Mixed Samples	94·5	·0765	94·43	94·4	–·1	–·03	..
3	,,	Trinidad	96·95	·0378	96·91	96·95	0·0	+·04	2·91
4	,,	Java	97·425	·0884	97·33	97·375	–·05	+·045	2·30
5	Musco.	St. Croix	85·8	·4118	85·45	85·5	–·3	+·05	1·91
6	Mol.	Cuba	89·4	·39	89·05	89·0	–·4	–·05	3·20
7	,,		89·225	·4204	88·85	88·85	–·375	0·0	2·85
8	,,		86·45	·7108	85·84	85·95	–·5	+·11	1·96
9	,,		90·675	·3204	90·39	90·45	–·225	+·06	3·20
10	,,		89·35	·8500	88·59	88·775	–·575	+·185	..
11	,,		89·4	·4554	88·99	89·0	–·4	+·01	3·01
12	,,	Cuba	88·4	·4924	87·97	88·0	–·4	+·03	2·64

In the technical analyses of sugar factories and refineries the dry defecation offers marked advantages.

By the commonly employed Cassamajor method of determining the quotient of purity of a sugar solution, it is necessary to take account of the amount of dilution caused by the addition of lead solution in clarifying. This is done by filling a flask graduated at 100 and at 110 c.c. to the 100 mark with the sugar solution, adding enough lead solution to decolorize, making up to 110 c.c. with water, filtering and

polarizing. The polarization is increased to 110% of itself to compensate for the dilution and multiplied by a factor corresponding to the density of the solution, whereby the purity is obtained. The error due to the volume of precipitate still remains. In the dry defecation no such precaution need be taken, as the concentration is unaffected by the defecating agent. After taking the density of the solution with a hydrometer in a tall cylinder, one adds dry subacetate of lead directly to the solution, shakes, filters and polarizes. This polarization multiplied by the factor for density gives the purity.

It is found that some refinery solutions, notably such as have been subjected to the influence of bone-black, have a tendency to coat the grains of lead salt with insoluble adherent crusts, preventing the solution of the interior portions. This is probably due to a preponderance of mineral matter, but is readily overcome by adding coarse dry sand with the lead salt before shaking. The attrition grinds off the crusts instantly, allowing the lead to be completely acted upon, and so defecating the solution.

Following are a few polarizations of typical samples from a refinery, showing the very close agreement between the two methods—an agreement as close as would obtain between two duplicate tests by the same method :—

Sample.	Observer.	Wet Method.	Dry Method.	Difference from wet.
Washed sugar solution..	A	60·4	60·3	−·1
	B	60·1	60·05	−·05
Bag filter washings	A	27·0	27·0	0
	B	26·9	26·9	0
Char ,, ,, ...	A	48·4	48·3	−·1
	B	48·3	48·2	−·1
Medium massecuite	A	30·7	30·6	−·1
	B	30·6	30·6	0
,, syrup	A	23·2	23·2	0
	B	23·2	23·2	0
Low sweet water	A	3·2	3·1	−·1
	B	3·1	3·0	−·1
Residual syrup	A	28·16	28·15	−·01
	B	28·16	28·20	+·04

A set of about 35 tests on refinery samples by different observers showed as close an agreement as between duplicate tests by the ordinary method, viz.: differences from 0 to ·2° and the average of the polarizations by the dry defecation was about ·02 of a degree lower than by the wet defecation. Strangely enough the error due to the volume of precipitate seems to be smaller in partially refined solutions than in raw sugars, although the volume of the precipitate may be as large or larger. This is probably due to other errors, which tend to compensate the former.

The dry defecation method has been employed for several months in two sugar refineries with perfectly satisfactory results, and with the added advantages of greater speed of work, the elimination of volume measurements and the simplification of calculations.

The first anhydrous subacetate the writer prepared for himself, but later it has been very satisfactorily prepared by E. R. Squibb and Sons. The sample tested contained 72·76% of lead as against 8·88% of lead in the solution usually employed, whose specific gravity was 1·1049 = 24·61° Brix. Thus 1· c.c. of the solution is equal to 0·1346 gms. of the dry salt, and this equivalent has been used in the experiment cited.

The writer trusts that these results may help to solve the difficult question of errors due to the volume of precipitate, and offers the above method as one which at least will go a long way toward arriving at correct results in optical sugar analysis.

W. D. HORNE.

AUSTRALIAN SUGAR BOUNTIES.

The Board of Trade have received, through the Colonial Office, a copy of the Sugar Bounty Act, No. 4, of 1903, under which bounties are granted to growers of sugar cane and beet. The Act provides that there shall be paid out of the Consolidated Revenue Fund to every grower of sugar cane or beet within the Commonwealth, in the production of which "white" labour only has been employed, on and after 28th February, 1903, or for a period of twelve months immediately preceding the delivery thereof for manufacture, a bounty on all such sugar cane or beet delivered for manufacture after the commencement of the Act and before 1st January, 1907. It is, however, provided that no bounty shall be payable in respect of the production of sugar on land which has been cultivated by other than "white" labour after a bounty has been paid in respect of the production of sugar thereon, and that no bounty shall be paid for any sugar cane or beet in respect of which any planting has been done by other than "white" labour after 28th February, 1903.

The bounty granted in the case of sugar cane shall be at the rate of 4s. per ton, calculated on cane giving 10 per cent. of sugar, and shall be increased or diminished proportionately according to any variation from this standard. The bounty in the case of beet shall be at the rate of 40s. per ton "on the sugar-giving contents of the beet."

All rebates of excise duty on sugar paid before the commencement of this Act will, it is stated, be taken to have been paid as bounties under the present Sugar Bounty Act.

TARIFF CHANGES AND CUSTOMS REGULATIONS.

The Board of Trade, have received, through the Foreign Office, a copy of a Note from the Belgian Government, announcing the decision arrived at by the Permanent Sugar Commission at Brussels with regard to the countervailing duties to be applied to sugars imported into the territories of the States parties to the International Sugar Convention from the undermentioned British Colonies. It is to be remembered, however, that in accordance with the declaration made by H.M. Government on the ratification of the Convention, there will be no penalisation of sugars imported into the United Kingdom from any British possessions; and, further, that it is not obligatory upon the other States parties to the Convention to apply these countervailing duties until an appreciable amount of sugar is actually imported into their respective territories from the Colonies concerned. The rates of duty in question are as follows:—

	Per 100 kilogs. Frs.	Cts.
Canada:—		
On refined sugar	3	63
South African Customs Union:—		
On raw sugar	2	05
On refined sugar	3	89
Commonwealth of Australia:—		
On raw sugar	0	94
On refined sugar	5	62

The Board of Trade have also received, through the Indian Office, a communication to the effect that the Government of India have decided to remit countervailing duties on sugar produced in any country that is a party to the Brussels Convention, (and not tran-shipped at, or transported through, a country that is not a party to the above Convention), which is covered by Consular certificate, showing that it was produced after 31st August, 1903, and that it has not received, and is not entitled to, bounty on production or export.

The certificate of the date of production and of absence of bounty, must be countersigned by the British Consul at the port of export or place of despatch.

Notifications to the above effect, and prescribing the form of certificate were, it is believed, issued by the Government of India on 2nd December.

It is further to be remarked that, subject to the above exemption as to the sugar of this year's crop, the countervailing duties, "special" and "additional," levied in India on 31st August, 1903, on sugar produced in countries which have joined the Brussels Convention, will continue to be levied until, but not beyond, the 31st March, 1904.

THE FUTURE OF THE WEST INDIES.

On the 11th November last Sir Daniel Morris, Imperial Commissioner of Agriculture for the West Indies, addressed a large and influential gathering in Kingstown, Jamaica, on the condition and prospects of the island.

He pointed out that at the time of the Royal Commission in 1897 the number of sugar estates in Jamaica was about 130; as some had since been superseded by banana plantations, the number at the present day was only about 100.

It was stated to the Commission that the yield per acre in sugar alone was about one ton, but for each ton of sugar they obtained 100 gallons of rum. It was impossible for them to estimate the real value of the sugar industry in Jamaica, unless they took into consideration the whole of the crop—that was the sugar, rum, and the molasses exported during the last ten years from Jamaica. In other parts of the West Indies, as in Barbados, molasses was nearly as valuable as sugar itself.

Dealing with the question of markets, he thought Jamaica would now have to meet with far more competition in the United States, but the prospects in the English and Canadian markets were brighter. One principal result of the abolition of bounties was that their credit had improved somewhat, though to what extent he could not say. It was a question for commercial men to decide, but doubtless the latter would be more favourably disposed now. He had been assured that the soil in Jamaica was very good soil, and would grow canes as well as that in any other part of the West Indies. He thought that coolie immigration, in spite of its undoubted expense, might prove a good thing for the island, and he believed that the Government would place no obstacle in the way of introducing more coolies if they were absolutely necessary for carrying on the industry.

It might be possible to extend cane farming in certain districts of Jamaica. He instanced one locality in the island where 15,000 tons of cane were bought from settlers. Growing canes was the most popular cultivation in the West Indies amongst the black people, consequently if arrangements could be made whereby cane farming might be extended, no doubt some of the difficulties connected with labour might disappear. It was very much in favour of Jamaica that there was practically no cane disease there. As to extraction on the island, he believed that on most estates it was too low to be productive. Whatever they did with their sugar, they must have better mills.

During his recent visit to the United States he was told by people interested in West Indian sugar that the preference offered by Canada to the West Indies was not available to the West Indies under certain circumstances. Previous to the abolition of European bounties, the preferential rebate offered by Canada to the West Indies of 33⅓ per

cent. reduction in the duty was non-effective owing to the United States Government charging a countervailing duty equal to the amount of the bounty paid on European beet when exported, thereby enabling the United States refiners to pay proportionately a greater premium for West Indian and other cane sugars than the Canadian refiners could afford to do, as the amount of the bounty was greater than the preference in the Canadian tariff. Now that bounties have been abolished and all sugars are on an equality in the United States and United Kingdom markets, Jamaica will not command the premium in New York which it along with other cane sugars did while bounty-fed beet was subject to a countervailing duty on entering the States. Therefore, it is from now on that the Canadian preference should show itself: and that Canadian refiners should be willing to pay a better price for West Indian sugars than can be obtained for them in other markets. The Canadian refiners will, of course, continue their efforts to secure British West Indian grown sugars at the same price as the United States and United Kingdom refiners will be willing to pay for them and take the benefit to themselves of the preferential rebate, so it rests with the sellers in the West Indies to reach an agreement between themselves, whereby all shippers will refuse to sell to Canada unless a premium is paid in proof of the preference Canada offers to the West Indies, which it was the intention of the Dominion Government should be given as an enhanced price to the West Indian planter for his sugar. An agreement might be arrived at, that a fixed minimum premium be established at which sales are to be made to the Canadian refiners, either direct or through selling agents whether in New York, London or Canada, and that wherever possible an extra price over this minimum premium should be extracted from the Canadian buyer, selling prices, of course, to be governed by what the Canadian refiners can buy other sugars at, but these buyers should at least be willing to pay half the amount of the preferential rebate in the Canadian tariff. The specific duty on sugar entering Canada is on raw, for a minimum polarization of 75°, 40 cents per 100 lbs., advancing 1½ cents per degree up to 100° paying 77½ cents. The duty on 89°, which is the basis of test for sale of Muscovado, is 61 cents, from which the preference of 33⅓ per cent. to British grown sugar is 20·33 cents per 100 lbs., and the duty on 96° test, which is the basis for sale of centrifugal refining crystal sugar, is 71½ cents, the preference on this rate being 23·83 cents per 100 lbs., and there really is no reason why the Canadian refiners should not pay the whole of the preferential rebate, as an extra return in the purchase price to the West Indian grower. Otherwise, the Canadian refiners will get their supplies of British West Indian sugar at nearly £1 per ton cheaper than anybody else, thereby increasing their own protection to that extent at the expense of the West Indies.

Belgium.

The exportations of both raw and refined sugar in 1902 sank very considerably, more especially those of the former, which were in quantity only half those of 1901 and a third of those of 1900, the year of their zenith. As compared with 1901, the value of the raw sugar exported to the United Kingdom fell by £560,000, and of that sent to Canada by £200,000. The chief causes of this were: (1) The reduction of the acreage under cultivation; (2) the poorness of the yield, which was 17 per cent. inferior to that of 1901; (3) the early sharp frosts, which affected the quality of the beetroot crops.

Imports of British sugar into Belgium :—

	1901. Tons.	1902. Tons.
Sugar, refined and unrefined	982	810
Syrups and molasses	325	206

Exports to United Kingdom during 1901 and 1902 :—

	1901. Tons.	1902. Tons.
Sugar, refined	23,821	8,789
,, unrefined	97,352	32,441

Besides this the following quantities were exported to India and Canada :—

	1901. Tons.	1902. Tons.
Canada (unrefined)	26,545	1,670
India (refined)	244	4,137

China.

Comparative figures of the imports of sugar are given below :—

	Quantity. 1901. Cwts.	1902. Cwts.
Brown	1,198,971	2,663,398
White	500,463	862,245
Refined	1,281,548	1,639,563
Candy	73,678	162,420
Total	3,054,660	5,327,626

High prices and the scarcity of native sugar caused foreign sugar to advance. Brown sugar, which in former years used to be largely re-imported viâ Hong-Kong, must last year have been derived from elsewhere—possibly the Philippines and Formosa—as the diminished exports from the southern ports cannot have created an abnormal increase of this kind. Similarly, the doubled import of candy sugar, which used also to re-enter China viâ Hong-Kong, must have come from Europe.

A general lowering of prices in order to drive beet sugar off the field is no doubt responsible for the all round advance in the above

classes and of refined sugar, the output of Hong-Kong refineries. As the customs do not classify beet sugar separately, it is impossible to ascertain to what extent it has gained ground, but as was pointed out last year, it is not likely to find favour with the Chinese, unless disposed of at a nominal figure.

The suggestion has been put forward that it may be practicable to cultivate beetroot in Manchuria, where, to judge from the circumstance that the three provinces took 106,500 cwts. more of sugar than they did in 1901, popular taste for sugar appears to be on the increase. Similarly, the northern port of Chefoo increased its consumption by 300,000 cwts.

Discouraged by bad crops and growing foreign competition owners of land in the south of China, formerly planted with sugar cane, are said to be turning their attention to other things.

Dutch Guiana.

The amount of sugar produced during 1902 was on the whole satisfactory.

	1902.	1901.
Vacuum pan, metric tons	13,046 ..	12,721
Rum, litres	1,017,353 ..	1,197,353

To the United Kingdom there was shipped direct some 4,666 tons of sugar, valued at £42,379. In addition to these, sugar products, valued at £3,714 were sent to Demerara for transhipment, principally to the United States.

Brazil.

Bahia.—Exports of sugar in 1902 were £9,000 (55 per cent.) less than in the preceding year. The total crop amounted to only 210,000 bags (that of 1901 being 340,000 bags), and this was nearly all consumed in Bahia or Rio de Janeiro, which accounts for the great falling off in exports.

A number of influential mill owners held an informal meeting at Bahia in November, 1902, in order to see whether means could not be devised to secure some of the profits which are at present made by the middlemen. The combination made by the owners was in so far successful that early this year the price of white sugar rose from 2d. to 5d. and 6d. the kilo. It is now proposed to form a legally constituted syndicate in order to further protect the interests of this important industry, and provide requisite funds for an experimental plantation for the study and improvement of the cane; sixteen large owners have promised their support to this scheme, which should be of great assistance to planters and small cultivators, for it is evident that a rise in the price of sugar will be followed by a similar improvement in the value of the cane.

PUBLICATIONS RECEIVED.

THE TECHNOLOGY OF SUGAR, by John Geddes M'Intosh. Scott, Greenwood & Co., London, E.C. 10s. 6d. net.

This book of 402 pages, of well and closely-printed matter, may prove interesting, and to some extent useful, to the "Sugar Works Chemist, the Engineer, and also the Public Analyst and others," for whom we are informed in the preface it is intended, and who are unable to read, in the original French or German, the treatises from which Mr. M'Intosh has compiled the bulk of the information contained in it.

As he seems to have taken a good deal of trouble over his task, it is to be regretted that his description of *Beetroot Sugar Manufacture* is mainly confined to France, for notwithstanding the start obtained from the favour lavished on it by the first Napoleon, the French industry has been left far behind by its German competitor, both in the matter of treatment, and in manipulation.

The account of *Cane Sugar Manufacture* is but meagre, and reads as if it related to a bygone time, since our author writes: "Ordinary big mills, with rolls 78 inches long and 30 inches in diameter, crush 250 to 300 tons of canes per 24 hours." But no mention is made of what we should call "big mills" nowadays, of which several in Cuba, Demerara, Honolulu, and elsewhere, are crushing 1,000 to 1,200 tons, and in some places 2,000 to 3,000 tons in 24 hours.

The importance of this improvement, which is not recorded, is perhaps less than that of another which has also escaped notice. Wet bagasse, we are informed, produces but little steam, "but as burning is the only way to get quit of it this has to be put up with, and the small number of calorics generated by it in the boilers is taken as much advantage of as possible." Evidently Mr. M'Intosh has not seen the large sugar estates where green bagasse is the only fuel used.

Sugar Refining is treated with a like scantiness of detail, and the little there is is not unfrequently inaccurate or misleading, and sometimes both one and the other. For instance, sucrose, or cane sugar, Mr. M'Intosh says, is obtainable from the juices of the sugar cane, the sugar beet, the sugar maple, the sugar palm, and various sweet fruits. With respect to the *chemical substance* called sucrose ($C_{12}H_{22}O_{11}$), an anhydride of glucose formed by the union of two molecules of the latter, by the elimination of one molecule of water, this statement is correct; but any good housewife will tell Mr. M'Intosh that *the sugar of commerce made from the sugar cane is cane sugar*, and the *sugar of commerce made from anything else is not cane sugar*, but something very different, and not nearly so good to eat, nor so wholesome.

But a really amazing statement is made at page 89, where the weight of the air held in solution by water is stated to be $\frac{1}{20}$th the weight of the latter! If this be a printer's error, it is one of a kind which ought not to have been allowed to pass uncorrected in a work having any claim, or even any pretentions, to technical usefulness. We are afraid that we cannot admit that it is a printer's error, for his remarks in the context, about the proportions of air pumps for vacuum apparatus, leave no doubt that Mr. M'Intosh believes that a cubic foot of water, weighing at 60° Fahr. 62·321 lbs., can hold in solution, and commonly does hold in solution, at normal atmospheric pressure, no less than 3·16 lbs. of air. It does not, and it cannot. River or canal water contains $\frac{1}{20}$th of its volume, spring or well water $\frac{1}{14}$th of its *volume*—not *weight*.

Another instance of similar inaccuracy, although of minor importance, is the statement at page 203 that pressures of $4\frac{1}{2}$ to $5\frac{1}{2}$ kilogrammes per square centimeter are equivalent respectively to 65 lbs. and 70 lbs. per square inch. As a matter of fact, they are equivalent to 64 lbs. and 78·2 lbs. per square inch respectively. Mr. M'Intosh's remarks about turbines are scarcely less misleading than the inaccuracies we have just quoted. One would suppose, from his book, that Weston's Centrifugal Machine, which was patented over 30 years ago, is only to be found in cane sugar factories, whereas it is in general use all over the world.

But nowhere is Mr. M'Intosh less felicitous than in his suggestion to substitute friction wheels of different diameters (see Diagram No. 68, page 292), for toothed crown wheels to drive mill rolls. It does not seem to have occurred to him that there can be no possible way of pressing the rolls together when friction wheels prevent it. But perhaps this does not matter, for he might start grinding with his rolls and friction wheels set up to his liking, and then no cane at all would go through his mill, and there would be an end of all his troubles, and his sugar crop in the bargain.

One further matter he treats of in his brief account of cane sugar manufacture which he might as well have left alone, for his description of the working of the diffusion plant at the "Magnolia" Estate in Louisiana is little more than ancient history, because Governor Warmoth found the plant, as so fully described by Mr. M'Intosh, so inefficient, that he threw it all out and replaced it by a new set of diffusion cells in two rows, and a large Rillieux evaporator. This new plant was working well in the crop of 1900-1901, and has continued to work well up to the present time.

We have not much more to say. At page 336 in the part describing the "Refining of Sugar," Mr. M'Intosh tells us that the specific gravity of liquor of 28° Beaumé is 1·225, and he says it contains two parts of sugar to one part of water. This is another instance of

inaccuracy and is misleading. Liquor of 28° Beaumé, as tables easily accessible will show Mr. M'Intosh, is of the density or specific gravity of 1·2407, and it contains 6·3994 lbs. sugar and 6·0146 lbs. of water per gallon. When it is added further on, in describing the first operation in refining sugar, which consists in the melting of raw sugar with water and steam in order to make a liquor of 25° to 33° Beaumé (save the mark), in the tanks called "blow ups," Mr. M'Intosh goes out of his way to state that the operation is not carried on with weighed or measured portions of sugar and water, but that the man in charge runs portions of each into the "blow-ups" just as he thinks proper, *his only guide throughout being a Beaumé Saccharometer*, we imagine that most of our readers will have no difficulty in judging for themselves whether the author is a practical man or not.

Difficulty has always existed in the way of fully intelligible communication between the designers and constructors of sugar machinery, and planters of sugar producing crops, and manufacturers of sugar. No doubt a comprehensive treatise setting forth in plain language "understandable of the people" the abundance of technical data which years of investigation and practice have established, would be useful to everyone concerned.

But two things there are, which must be absolutely inadmissible in such a work—Blunders and Puzzles.

We have received the 1904 catalogue of Messrs. Watson, Laidlaw and Co., Glasgow, which is a profusely illustrated publication of some 140 pages, dealing with every kind of machine or apparatus manufactured by the firm. Centrifugals and hydro-extractors naturally receive the most attention. In the Supplement A., accompanying the catalogue, the latest designs are shown. One novelty is a set of six water-driven machines, arranged in a circle. These are meant to be placed immediately below the vacuum pan receiver, which is fitted with a charging spout capable of moving round the entire circle. From a publisher's point of view this catalogue leaves nothing to be desired, save possibly stiffer backs for the cover.

Practical Notes on the Driving of Centrifugal Machines by Belt, Water, and Electricity, is the title of a small 4to pamphlet issued by the well-known firm of Messrs. Pott, Cassels and Williamson. The gist of it is an enunciation of the superiority of the electric drive for centrifugals over the other two systems; and there is no doubt that for those factories where electric power is available and cheap the merits of this method are worth considering The pamphlet will, we believe, be sent free on application.

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. Thompson, C.E., F.C.S., M.I.M.E., Chartered Patent Agent, 6, Lord Street, Liverpool; and 322, High Holborn, London.

ENGLISH.—APPLICATIONS.

25481. A. Ashworth, Bury. *Improvements in the production of saccharin.* 23rd November, 1903.

26665. W. C. Salisbury and A. J. Kramper, London. *An improved process of obtaining syrup from beets, cane, corn, root crops or other substances containing saccharine matter.* (Complete specification.) 5th December, 1903.

26779. J. C. F. Lafeuille, London. *Improvements in and in connection with annular moulds for treating sugar by centrifugal action.* 7th December, 1903.

ABRIDGMENTS.

18044. J. Krivanek, Kiew, Russia. *Improvements in and relating to the manufacture of sugar.* 20th August, 1903. This invention has for its object a process for making sugar in slabs, strips, or blocks characterised by the fact that the mass is filled in vacuo into the moulds and that the syrup contained in the mass is first completely driven off with moistened air, before a commencement is made with the addition of the better syrup.

28186. G. Deutsch, Vienna XIX. *Improvements in apparatus for whitening sugar in centrifugal machines by means of steam.* 20th December, 1902. This invention has for its object an apparatus for whitening sugar in centrifugal machines by means of steam, characterised by the interposition between the steam main and the steam spraying nozzle, which is placed in the centrifugal machine, of a combined steam-drier and wire-drawing valve, from which the separated water mixed with steam is allowed to flow into the casing of the centrifugal while steam of higher temperature than would correspond to its pressure is caused to flow to the nozzle.

IMPORTS AND EXPORTS OF SUGAR (UNITED KINGDOM,

To end of November, 1902 and 1903.

IMPORTS.

Raw Sugars.	Quantities.		Values.	
	1902.	1903.	1902.	1903.
	Cwts.	Cwts.	£	£
Germany	6,020,178	5,009,176	2,098,214	2,114,343
Holland	313,902	187,450	101,471	72,541
Belgium	563,278	674,363	200,014	279,143
France	1,702,168	527,521	656,674	230,794
Austria-Hungary	121,206	1,588,984	42,478	666,813
Java	....	449,261	....	218,536
Philippine Islands	5,430	70,646	1,680	25,285
Peru	126,814	333,824	44,206	137,290
Brazil	565,507	69,148	186,518	27,074
Argentine Republic	623,371	418,386	229,629	184,711
Mauritius	323,948	305,164	111,398	109,396
British East Indies	182,979	273,598	67,375	101,153
Br. W. Indies, Guiana, &c.	1,231,098	597,333	726,448	359,425
Other Countries	151,550	922,894	58,674	425,893
Total Raw Sugars	11,931,429	11,427,748	4,524,779	4,952,397
Refined Sugars.				
Germany	12,404,397	13,302,649	6,432,321	6,983,814
Holland	2,194,408	2,029,951	1,258,785	1,193,378
Belgium	142,972	125,507	82,541	73,642
France	2,205,483	816,245	1,157,219	463,038
Other Countries	32,752	870,048	15,013	431,162
Total Refined Sugars	16,980,012	17,144,403	8,945,879	9,145,034
Molasses	1,252,831	1,510,036	242,497	275,954
Total Imports	30,164,272	30,082,187	13,713,155	14,373,385

EXPORTS.

British Refined Sugars.	Cwts.	Cwts.	£	£
Sweden and Norway	39,351	31,879	21,391	16,076
Denmark	122,934	92,699	62,210	50,520
Holland	66,011	62,990	34,510	33,762
Belgium	9,343	10,727	4,648	5,470
Portugal, Azores, &c.	7,712	9,693	3,863	5,529
Italy	22,664	8,132	10,669	3,780
Other Countries	394,969	767,893	233,170	472,759
	662,984	984,013	370,461	587,896
Foreign & Colonial Sugars.				
Refined and Candy	42,588	40,412	27,202	25,225
Unrefined	84,818	56,038	41,779	29,706
Molasses	2,528	1,889	996	905
Total Exports	792,918	1,082,352	440,438	643,732

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1903. Tons.		1902. Tons.
Total Receipts, 1st Jan. to Dec. 17th ..	1,589,834	..	1,746,319
Receipts of Refined ,, ,, ,, ..	1,364	..	18,778
Deliveries ,, ,, ,, ..	1,576,130	..	1,768,453
Consumption (4 Ports, Exports deducted) since 1st January	1,627,156	..	1,717,611
Importers' Stocks (4 Ports) Dec. 9th ..	16,089	..	3,178
Total Stocks, Dec. 30th	64,000	..	136,076
Stocks in Cuba ,, ...	105,000	..	51,500
	1902.		1901.
Total Consumption for twelve months ..	2,566,108	..	2,372,316

CUBA.

STATEMENT OF EXPORTS AND STOCKS OF SUGAR, 1902 AND 1903.

(Tons of 2,240lbs.)	1902. Tons.		1903. Tons.
Exports	761,077	..	879,200
Stocks	68,727	..	122,638
	829,804	..	1,001,838
Local Consumption (twelve months)	40,250	..	39,570
	870,054		1,041,408
Stock on 1st January (old crop)	19,873	..	42,530
Total production for season	850,181	..	998,878

J. GUMA.—F. MEJER.

Havana, 30th November, 1903.

UNITED KINGDOM.

STATEMENT OF IMPORTS, EXPORTS, AND CONSUMPTION FOR ELEVEN MONTHS ENDING NOVEMBER 30TH.

SUGAR.	Imports. 1903. Tons.	Imports. 1902. Tons.	Imports. 1901. Tons.	Exports (Foreign). 1903. Tons.	Exports (Foreign). 1902. Tons.	Exports (Foreign). 1901. Tons.
Refined	857,220	849,000	926,062	2,021	2,129	3,418
Raw	571,387	596,571	583,096	2,802	4,241	5,622
Molasses	75,502	62,642	78,655	94	126	2,501
Total	1,504,109	1,508,213	1,587,613	4,917	6,496	11,541

HOME CONSUMPTION.

	1903. Tons.	1902. Tons.	1901 Tons.
Refined	807,975	845,675	—
Raw	411,901	573,449	—
Molasses	72,384	60,336	—
Total	1,292,260	1,479,460	—
Less Exports of British Refined	49,201	33,149	—
Net Home Consumption of Sugar	1,243,059	1,446,311	1,539,767*

* Trade estimate.

STOCKS OF SUGAR IN EUROPE AT UNEVEN DATES, DEC. 1ST TO 30TH, COMPARED WITH PREVIOUS YEARS.

IN THOUSANDS OF TONS, TO THE NEAREST THOUSAND.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	TOTAL 1903.
93	1376	810	611	307	3198

	1902.	1901.	1900.	1899.
Totals	3057 ..	2952 ..	2433 ..	2208

TWELVE MONTHS' CONSUMPTION OF SUGAR IN EUROPE FOR THREE YEARS, ENDING NOVEMBER 30TH, IN THOUSANDS OF TONS.

(From Licht's Monthly Circular.)

Great Britain.	Germany	France.	Austria.	Holland, Belgium, &c.	Total 1902-03.	Total 1901-02.	Total. 1900-01.
1694	862	580	421	507	4065	4026	4117

ESTIMATED CROP OF BEETROOT SUGAR ON THE CONTINENT OF EUROPE FOR THE CURRENT CAMPAIGN, COMPARED WITH THE ACTUAL CROP OF THE THREE PREVIOUS CAMPAIGNS.

(From Licht's Monthly Circular.)

	1903-1904. Tons.	1902-1903. Tons.	1901-1902. Tons.	1900-1901. Tons.
Germany	1,940,000 ..	1,748,556 ..	2,304,924 ..	1,984,186
Austria	1,230,000 ..	1,057,692 ..	1,302,038 ..	1,094,043
France	770,000 ..	833,210 ..	1,183,420 ..	1,170,332
Russia	1,200,000 ..	1,250,000 ..	1,098,983 ..	918,838
Belgium	225,000 ..	215,000 ..	334,960 ..	393,119
Holland	125,900 ..	102,411 ..	203,172 ..	178,081
Other Countries.	410,000 ..	350,000 ..	393,236 ..	367,919
	5,900,000	5,556,869	6,820,733	6,046,518

THE

INTERNATIONAL

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Budget Prospects.

With the approach of Spring, the annual speculations regarding the character of the next Budget invariably crop up. As a starting point this year, we have assurances that the income to be derived from last year's Budget is not coming up to expectations, and that therefore economy will be a guiding feature in the forthcoming proposals. Our chief concern is the tax on sugar. This has always been an unpopular impost in certain interested quarters, and there is no doubt that if the manufacturers in this country of goods in which sugar forms an ingredient have been hit by the changes in the sugar legislation instituted the last year or two, they owe it to the import tax of 4s. 2d. per cwt., and not, as they loudly assert, to the changes brought about by the Brussels Convention. But how far the consumer has been affected is really the only point to be seriously considered, and there is little reason for supposing that he has suffered any appreciable loss. Only last October a member of a firm of retail grocers having shops all over the Kingdom stated that their prices for sugar were the same as had held for some years past. The tax of 4s. 2d. has therefore been largely paid by the middlemen. Whether this tax will now be modified, or even withdrawn, remains to be seen; but we rather fancy neither step will be taken this year. We should have preferred to have seen it reduced to one-half in the case of sugar coming from British Colonies, while fully retained for foreign sugar; but we are, unfortunately, precluded from taking such a step owing to the provisions of the Brussels Convention, which debar us from granting any preferences to our Colonial sugar for the

next five years at least. As surprise has been expressed in certain quarters that a Government of which Mr. Chamberlain was a guiding hand should have consented to so tie its hands, it may as well be pointed out that, at the time the negotiations were proceeding it looked as if a refusal on our part would have tended to wreck the Convention. Had the present day views on fiscal reform been broached and similarly supported two years earlier, the Government might have summoned up enough courage to stick to Colonial preference whatever the other States might have to say. But apparently the necessary courage was not forthcoming, hence the perpetration of what was to us a blot in an otherwise successful Convention. Nevertheless, when we consider that the present Government may, for all we know, be turned out of office in the near future and replaced by a less "Imperially-thinking" body of politicians, we may as well be thankful that so much has already been accomplished towards the attainment of fairer trade relations in sugar.

Rapid Crystallization Without Motion.

In a short paper read before the Berlin Congress of Applied Chemistry, last June, M. Maurice Lambert, of Toury, France, gave some details of a process of rapid crystallization without motion which has been at work for the last four years at the Toury sugar refinery. It is founded on purely chemical principles. This factory, like most others, is arranged for working in vacuum. The runnings from the 1st product are concentrated in vacuo at 90° C. to 40° Bé., then drained off and passed into so-called crystallizers wherein the masse-cuite without any stirring crystallizes out fully in 24 hours. The chief rôle in this process lies in the crystallizers; these consist of trapeze-shaped receptacles which with their partitions are made of sheet metal. The bottoms possess conical openings which can be closed when required. At the end of 24 hours a large amount of very fine crystals has formed in the mass, and cooling has rendered the contents very concentrated. Hereupon the bottom apertures are opened and the molasses drained off. This draining lasts 70-80 hours, after which the bottom doors are again closed. The masse-cuite remaining in the crystallizers is then dissolved in 2nd saturation juice. By means of a circulating system the juice can pass repeatedly through the crystallizer, entering at the bottom and spreading through the sugar mass; after being sufficiently concentrated it flows off at the top through a drain pipe. Lest the juice should get cold during circulation, it passes through a heater previous to entering the crystallizer. The circulation is fully automatic, so that very little supervision is needed. When the sugar solution in the crystallizer attains a concentration of 28° Bé. to 30° Bé. it is filtered and is then completed.

The results obtained have been as follows:—The output in refined sugar amounted to 82–88% of the beet sugar, and only 4 kg. of raw yellow sugar were turned out per 100 dz. refined. These results have been obtained only by means of two saturations without sulphuric acid.

Molasses in Canada.

A copy of a further and supplementary Customs Memorandum has been received by the Board of Trade relating to the duty payable on molasses imported into the Dominion of Canada, which is as follows:—

" In view of the frequent importations of molasses found to contain " an admixture of glucose, it is ordered that $\frac{3}{4}$ cents per lb. duty be " collected on molasses entered at Customs in Canada, and claimed " to test not less than 35° pending test by polariscope at the Customs " Department at Ottawa—subject, however, to refund of duty if the " molasses be subsequently found entitled to entry under Tariff item " 441. In the case, however, of molasses imported direct to a " Canadian port from the West Indies or Guiana, the Collector may " allow delivery on payment of duty under Tariff item 441, upon " importers undertaking to amend the entry when so required, if the " Collector deems it advisable to do so after examination of the " importation."

It should be added that the text of Tariff item No. 441 of the Customs Act 16 of 1897, above referred to, is as follows:—

" Molasses produced in the process of the manufacture of cane " sugar from the juice of the cane without any admixture with any " other ingredient, when imported in the original package in which " it was placed at the point of production, and not afterwards " subjected to any process of treating or mixing, the package in " which imported, when of wood, to be free:—

	Per gallon.
" *(a)* Testing by the polariscope, 40° or over....	$1\frac{3}{4}$ cents
" *(b)* When testing by the polariscope less than 40° and not less than 35°...........	,,

[" With an additional duty of 1 cent per gallon for each degree or fraction of a degree less than 40 degrees."]

Messrs. McOnie, Harvey & Co., Ld., Glasgow, have opened a London Office at 27, Mincing Lane, E.C. It should be pointed out that the London office of Mr. Robert Harvey, Chairman of that firm, is at the same address, and not in *Mark* Lane as stated in our January number.

For the paper " A Study in Raffinose Determinations " appearing on pages 20–27 of the present volume, we were indebted to the *Journal of the American Chemical Society;* but by an oversight we omitted at the time to give them credit for the same.

THE FRENCH SUBSTITUTE FOR REFINING IN BOND.

Thirty years ago the French beetroot sugar factories received no bounties; they worked strictly "in bond," no duty was paid on the raw material—the roots—and therefore the sugar produced remained "in bond"—that is, no duty had yet been paid on it, and no draw-back was, therefore, required when the sugar was exported. The French Government found it quite practicable to treat hundreds of factories scattered over the rural districts under the strictest excise supervision, and to extend that supervision to the sugar which travelled about the country, bound either to the Paris refineries, to bonded warehouses, or to the shipping ports for exportation. It was a great undertaking, but it was done with perfect ease, and with absolute efficiency.

At that time our Government called on the French Government to apply the same system to the three or four monster refineries in Paris, and thereby to abolish the great bounty which those establishments were enjoying, owing to the fact that the sugar, when it reached the refinery, was charged with a duty on the basis of an entirely erroneous estimate of its yield, while the full duty on refined sugar was returned to the refiner on its exportation. What could be done with hundreds of beetroot factories scattered over the face of the country could be much more easily accomplished with three or four refineries under the very eyes of the authorities in Paris. It appeared incredible that the French Government should first go to enormous trouble and expense to protect the revenue and prevent their agricultural sugar industry from obtaining the slightest bounty, and then allow the revenue to slip through their fingers when this great national production passed through the hands of three or four Paris refiners.

When the French Government replied with a *non possumus* it was evident that they were determined to maintain the Paris refiner's bounty. No other valid reason was given or suggested, As time went on, however, the French Government, for the protection of its revenue, saw fit to reduce this bounty by improving the method of estimating the yield. Saccharimetry was substituted for classification by colour. But that gave no *international* security for the abolition of the bounty. At the Paris Conferences of 1876-77 this was very clearly demonstrated, and therefore, when the Conference assembled again in 1888, the British Delegates, well supported by Belgium and Holland, insisted on the matter being made quite clear in the wording of the Convention, which accordingly said:—

"The High Contracting Parties engage to levy the tax on the quantities of sugar intended for consumption without granting on

exportation any drawback or repayment of duties, or any writing off which can give rise to any bounty."

This was quite clear. Unfortunately the British Government failed to ratify the convention. But as time went on it was alleged that the French Government had at last adopted Refining in Bond. This, it appears, was not the case. They did, indeed, make some pretence of excise supervision, but they still charged the duty on the raw sugar on the basis of its analysis, and they did not even attempt to verify this presumed yield by weighing the refined sugar at the other end of the process. They declared that it was quite sufficient to examine the molasses (!) and see that the quantity of sugar contained in it corresponded with the deductions established by the analysis of the raw sugar. This was a far more elaborate and troublesome process than the simple weighing of the refined sugar as it went out. Why was a difficult proceeding substituted for an easy one? They said that the weighing of the various parcels of refined sugar would be impossible. If so, then how is it that it is done successfully and easily in this country and in all the other countries which are parties to the present Convention?

But even if the refined sugar were weighed there would still be no international security against bounties, unless they adopted the principle laid down in the passage quoted above from the Convention of 1888. Really, the only object of Excise supervision—"Refining *in bond*"—is to do away with the charging of duty on the raw sugar, to abolish the estimated yield, and to levy the duty on that portion of the refined sugar which goes into consumption, exporting the balance "in bond," that is, without its having paid any duty, and, therefore, without its claiming any drawback. To this, again, the French Government reply that they require they charge for duty on the raw sugar as a security against fraud. It is no security. Their security for the revenue is the Excise supervision and the weighing and taxing of all the products of the refinery. If that is not considered by them to be sufficient, by all means let them weigh and analyse the raw sugar as carefully as they like. But directly the charge the duty on it the security, from an international point of view, is gone. If we know that duty is paid only on the refined sugar as it goes into consumption, and that exported sugar receives no drawback, then we are convinced that the bounty is abolished. We do not care then whether the Excise supervision be good or bad, whether the analysis be right or wrong. But so long as duty is paid on the raw sugar and drawback paid on the refined we have nothing to rely upon but the assurance of the French Government that their accounts are well kept. That is no international security; and, moreover, the very fact of their clinging to a difficult, complicated and unreliable system when an easy, simple, and secure one would better answer the purpose must necessarily give rise to the very natural

assumption that there is some hidden reason for so tortuous a proceeding.

It appears from the *Exposé des Motifs* of the new French *Projet de loi* that this question has been seriously raised by the Permanent Commission at Brussels, and that the French Government have been requested to put their legislation into conformity with the terms of the Convention. A Bill has, consequently, been brought in and is now published. It professes to be a Bill for refining in bond, but it is nothing of the kind. The sugar is not *in bond*, the duty is still to be paid on the raw sugar, and the refined sugar exported will still receive a certificate of export, which is as good as a bank note for 25 fr. per 100 k.

Again it seems that there must be some reason for clinging to a bad and difficult system when a good and easy one would appear to be preferable, even from the point of view of the French Revenue no less than from that of the International Abolition of Bounties. What is this reason? Unless it be a very good one and speedily given, we can only infer that there must be something behind which it is not desirable to disclose.

There was a Convention in force for the abolition of bounties from 1864 to 1874, the terms of which were never carried out by France. Are we to find the same thing happen with the Convention of 1902? We cannot believe that the other countries, who have all put their refineries under a strict system of refining in bond, will tolerate this attempt to evade the terms of the Convention.

STOCKS OF SUGAR ANTICIPATED ON SEPTEMBER 1ST, 1904.

(Abridged from the *Sucrerie Belge*).

Since 1896 we have endeavoured at the beginning of January each year to calculate the stocks of sugar that would be in existence the following 1st of September. In almost every case our figures were justified, with the exception of last year when the figures for tons in raw sugar exceeded our estimate by 289,586 tons. The principal cause of this discrepancy was due to the varying calculations for cane sugar. Save in Java, no definite means exist for accurately gauging the production of cane sugar in the various countries, hence we have had to fall back on the mean calculations of three experts. Their original average was a surplus of 12,707 tons, but it was subsequently altered to 141,492 tons (mean). This difference, added to that due to an apparent decrease in consumption previous to last September in countries which were about to abolish their bounties, accounts fully for the above mentioned discrepancy.

But there is still greater difficulty in calculating to-day the stocks available next September owing to considerable changes brought about by the new regime inaugurated by the Brussels Convention. We still think however that the attempt is worth making.

The stocks existing on December 1st, 1903 (from which date the estimate begins) were

	Tons in Raw Sugar.
December 1st, 1903	3,566,900
,, ,, 1902	3,469,300
Difference	97,600

The total quantities of sugar available between December 1st and September 1st next compared with those of the preceding campaign are estimated as follows (in tons of raw):—

	1903-04.		1902-03.
Stocks of sugar on 1st December	3,566,900	..	3,469,300
Germany (production)..	515,849	..	507,065
Austria-Hungary (production)	294,025	..	300,911
France (production)	178,971	..	154,567
Belgium ,, ...	27,981	..	30,750
Holland ,, ...	14,862	..	18,675
Other European Countries (production).	——	..	——
Cane sugar (difference)	287,774	..	——
	4,886,362	..	4,481,268

being an increase of 405,094 tons.

The figures of cane sugar are estimated from the following experts' figures:—

	1903-04.		1902-3.		Difference.
F. O. Licht	4,000,000	..	3,687,909	..	312,091
Willett & Gray	4,437,800	..	4,144,569	..	293,231
Prager Zuckermarkt ..	4,433,000	..	4,175,000	..	258,000
			Mean	..	287,774

But from this figure of 405,094 tons the increase in consumption in the countries parties to the convention will detract somewhat this year. We believe, for reasons previously given, that this increase will amount to 25 %.

Now the consumption in those countries has been

From September 1st, 1902 to September 1st, 1903 ..	1,503,275
,, ,, ,, ,, December 1st, 1902	503,361
Difference (roughly)	1,000,000

Hence an increase in consumption of 250,000 tons refined or 278,000 tons raw may be looked for.

The excess is consequently reduced to $405{,}094 - 278{,}000 = 227{,}094$ tons. An increase in consumption may also be looked for in the

United Kingdom and the United States of America. But on the other hand, we may be able to raise the extent of production of sugar in Europe; so that all things considered, it is safe to admit that the stocks of sugar on September 1st, 1904, will not be appreciably inferior, and may be slightly higher, than those of September 1st, 1903.

We therefore estimate the stocks on 1st September as follows:—

		Tons.
Stocks of sugar on September 1st,	1900	534,720
,, ,, ,,	1901	911,776
,, ,, ,,	1902	1,809,511
,, ,, ,,	1903	1,775,827
,, ,, ,,	1904	1,800,000 (?)

It is easy to account for these figures, We need not expect any diminution in the production of cane sugar. On the contrary, it is probable that the suppression of bounties in Europe and the new reciprocity treaty concluded between Cuba and the United States will result in a fresh increase in the production of cane sugar, though this may possibly be balanced by an increase in the consumption of countries over-sea.

On the other hand the European Governments in general, and Austria-Hungary, and Holland in particular, do not sufficiently grasp the advantages offered from an economical point of view in the suppression, or at least in the reduction, in the sugar duties, so that the public is still prejudiced against the use of sugar. It will doubtless be a good while yet ere the consumption increases in desirable proportion.

Consequently for the time being the only method for raising the price of sugar is a serious reduction in beet sowings, especially in those "Convention" countries which export sugar, and whose actual production is—

	Tons (raw).
Germany	1,897,300
Austria-Hungary	1,163,000
France	778,200
Belgium	199,200
Holland	123,200
Total	4,160,900

To reduce the stocks by 500,000 tons, it will be necessary to reduce the sowings of beet at least 12%, or even 15 to 20% if we take into consideration the exceptionally poor yields obtained this year in most countries. And this will be particularly necessary in the case of Germany and Austria-Hungary who between them account for more than three-fourths of the area it is proposed to reduce.

But will they decide to so act? Unfortunately we have good reason to doubt it, for the sugar associations of Germany and Austria will not even take the trouble to consider seriously the propositions which have been made by their colleagues in Belgium and France with a view to regulating by united action the exportation of sugar by means of a reduction in the production.

NEW CENTRAL SUGAR FACTORY FOR ANTIGUA.

For many years it was contended that the abolition of the Foreign Sugar Bounties would lead to an improvement in the manufacture of sugar in the West Indian Islands, and that with improved machinery they would be able to hold their own against the competition of all comers. That this contention was justified is proved by the establishment of the Antigua Central Factory, Limited. This Company, which has received the support of the British Government, has been formed for the purpose of erecting a modern factory with all the latest improvements for the manufacture of Cane Sugar in the Island of Antigua, and the promoters have placed the order in the hands of the well-known, long established firm of The Mirrlees Watson Company, Ltd., of Glasgow. The contract is unique in many respects. In the first place the factory has to be to the entire satisfaction of the British Government, and in the second place the Mirrlees Watson Company have undertaken the entire responsibility of supplying, erecting and running a modern factory. They have selected the site, and on what was a flat pasture they intend to erect, equip, and to turn over to the proprietors a thoroughly well-arranged and up-to-date factory. The present scheme is for a factory to make 3,000 tons of grey crystals in 100 days, but the factory is so designed that without disturbing any of the arrangements it may be doubled or extended to any desired extent. The plant now in the course of manufacture consists of a powerful double crushing set of mills with provision for hot and cold maceration. Sulphuring arrangements are provided, so that if necessary a very high class of sugar, ready for immediate consumption, may be turned out. The clarifying arrangements are of the most modern high pressure type, with ample provision for the subsidence of the juice, with high pressure eliminators for the further cleaning of it before it enters the triple effet. The evaporating arrangement consists of a modern triple effet with large vapour pipes and especially designed arrangements for circulation of the juice and of the steam, and very considerable attention has been bestowed upon the arrangements for the removal of the water of condensation from the various calandrias. Two

vacuum pans are provided of ample capacity with large heating surface, a central condensation plant being provided for the whole of the evaporating plant with very high-class dry slide valve air pump, Torricellian condenser, and cooling tower. The first sugars are cured hot, the dry sugar being conveyed, elevated, and delivered into the sugar store without any handling. The resultant molasses is cleaned, re-boiled, and struck into malaxeurs, the resultant masse-cuite being delivered by a magma pump into special 2nd sugar centrifugals. Arrangements are also provided for the use of second sugar as seed grain, if so desired. Ample plant is provided for the treatment of scums in large blow-ups and filter presses, with a light railway for the removal of the filter press cake. The green megass from the mills is delivered immediately into two of the most modern green megass burners attached to water tube boilers, and a carrier from the megass burners is so arranged that any surplus megass can be conveyed to a megass store, and as occasion arises withdrawn and returned to the boilers with a minimum amount of handling. A fully equipped machine shop is attached to the factory, with a travelling crane commanding the whole of the grinding plant, so that any part of this plant may be examined, overhauled, or replaced in the shortest possible time. The works are to be illuminated throughout by electric light. The buildings are of iron, specially designed to resist hurricanes, to which this island is subject.

Altogether this is a most modern and up-to-date plant, and the promoters and builders believe that sugar will be produced at a cheaper rate than in any other sugar-growing country, owing to the very careful manner in which the whole of the arrangements and plant have been designed.

The consulting engineer under whose supervision the work is being executed is Claude T. Berthon, Esq., A.M.I.C.E., of Ceylon House, Eastcheap, London, E.C.

In Fiji some 30,000 acres are under cane cultivation. Of the five existing sugar factories, three belong to the Col. Sugar Refining Co., of Sydney.

The latest use to which the banana has been put is to manufacture therefrom a flour for making brown bread. This bread has a flavour peculiar to itself, and one that may not be taken to at first trial. But it compares favourably with most other brown breads, and is claimed to be more nutritious and digestible than any of them. The flour known as "Bananine" is manufactured solely by Messrs. Jos. Appleby & Sons, Ld., Bootle, Liverpool, and those to whom brown bread is a favourite article of diet might do well to give it a trial.

EGYPT.

The Present Situation in the Sugar Trade.

The prophecy that, in consequence of the increased activity shown by the "Société Générale des Sucreries et de la Raffinerie d' Egypte" in purchasing the nine *Daira Sanieh* factories, the imports of sugar into Egypt would suffer a decrease, is well on the way to fulfilment; and the particular conditions of the first seven months of the current year show an even greater fall than had been anticipated.

The imports of European sugar into Egypt, which reached their zenith in 1902, have been as follows the last three years:—

	1902.	1901.	1900.
	Tons.	Tons.	Tons.
Austria-Hungary	8,625	4,437	2,987
Russia	717	2,938	2,946
Germany	856	31	25
Other countries	164	18	83
	10,362	7,424	6,041

The imports during the first seven months of 1903 were as follows:

	1903.		1902.	
	Tons.	E. lbs.	Tons.	E. lbs.
January	712	6,975	1,659	16,661
February	526	5,255	1,302	12,537
March	439	4,532	1,044	9,764
April	230	2,444	939	8,845
May	149	1,605	845	7,859
June	408	4,071	618	5,475
July	362	3,764	718	6,280
	2,826	28,646	7,125	67,421

The countries concerned with these imports, and their respective shares, were:—

	1903.		1902.	
	Tons.	E. lbs.	Tons.	E. lbs.
Austria-Hungary	2,293	23,431	5,495	52,896
Russia	522	5,084	713	6,446
Germany	—	—	844	7,213
Other Countries	11	131	73	866
	2,826	28,646	7,125	67,421

As seen, the decrease in the Austrian supply is the most striking and seems all the more noteworthy when we perceive that of the quoted 2,293 tons of Austrian sugar, nearly 1,800 tons were delivered in the first four months, whilst in the remaining months of May, June and July, only 500 tons were dispatched from Trieste. The Austrian production has therefore fallen to a scarcely appreciable minimum. The Russian supply, on the other hand, which in former

years was of little import, appears to be on the increase and the view is now generally held that the Russian sand sugar is the only European production which can look for an increased sale in Egypt. It is its cheapness alone that accounts for its success. Just lately large buyings of this commodity have been undertaken for October-December delivery at prices which varied between 21½ and 22½ frs. per 100 kg. c.i.f. Alexandria. These quotations are so low that they not merely defy competition, but even the "Société des Sucreries d'Egypte" has been outbid and, far from hindering the Russian import, has bought large quantities of this sugar on her own account.

The above cited decrease in the sugar imports of Egypt, cannot be a matter of surprise; it is more a question of wonder how a land that for some years has produced itself 90,000 to 95,000 tons per annum of raw sugar and exported 50-60,000 tons of it, should resort to supplying its own wants by the importation of 6,000 to 10,000 tons of European sugar. This anomaly is however to be explained by the fact that the Egyptian sugar production has hitherto been badly organised, having been in large part in the hands of a Government administration which has naturally restricted freedom of action, without which no commercial scheme can hope for success. But to-day the Egyptian sugar industry is almost exclusively united in the hands of a private company which possesses unlimited means and property: hence the struggle of the import trade against local production is not only much more severe, but quite hopeless.

The "Société Généralé des Sucreries d'Egypte" has undertaken to monopolise not only the production, but also the trade in sugar in Egypt. Its tactics are to always underbid the European quotations by ½ or 1 fr. and it is just this action which renders futile the efforts of outside competition. The company cannot, however, do otherwise for it must safely secure the home market, or else the realisation of its production would be endangered; especially as this production will increase in large proportion during the coming year. Though of the nine purchased Daira factories, the company only intends to run three provisionally, yet there are six factories associated with their present business working all the year round.

Such a production must result in a corresponding sale, and for this purpose the whole requirements of Egypt will no longer suffice. The Company have therefore endeavoured for some years past to secure another market for their production, and their attempts to get a footing in India, Syria, and the Red Sea ports show increasing results. The European production will therefore not only realize the necessity of leaving the Egyptian market to Egyptian production, but will meet with the latter in other places and may have to engage in severe competition therewith.—*(Zeitschrift des Vereins.)*

UNITED STATES.

New Sugar Definitions.

The U.S. Department of Agriculture, in its circular No. 10, has set up the following standard definitions for sugar, sugar products, glucose products, and candy :—

(a.) Sugar and Sugar Products.

Definition.

1. Sugar is the product chemically known as sucrose (saccharose) chiefly obtained from sugar cane, sugar beets, sorghum, maple, or palm.

Standard.

Standard sugar is white sugar containing at least ninety-nine and five-tenths (99·5) per cent. of sucrose.

Definitions.

2. Granulated, loaf, cut, milled, and powdered sugars are different forms of standard sugars.
3. Maple sugar is the solid product resulting from the evaporation of maple sap.
4. Masse-cuite, melada, mush sugar, and concrete are products obtained by evaporating the purified juice of a sugar-producing plant, or a solution of sugar, to a solid or semi-solid consistence in which the sugar chiefly exists in a crystalline state.
5. Molasses is the product left after separating the sugar from masse-cuite, melada, mush sugar, or concrete.

Standard.

Standard molasses is molasses containing not more than twenty-five (25) per cent. of water nor more than five (5) per cent. of ash.

Definitions.

6. Syrup is the product obtained by purifying and evaporating the juice of a sugar producing plant without removing any of the sugar.
7. Sugar cane syrup is a syrup obtained by the evaporation of the juice of the sugar cane or by the solution of sugar cane concrete.
8. Sorghum syrup is a syrup obtained by the evaporation of sorghum juice or by the solution of sorghum concrete.
9. Maple syrup is a syrup obtained by the evaporation of maple sap or by the solution of maple concrete.
10. Sugar syrup is a syrup obtained by dissolving sugar to the consistence of a syrup.

Standard.

Standard syrup is a syrup containing not more than thirty (30) per cent. of water nor more than two and five-tenths (2·5) per cent. of ash.

(b.) Glucose Products.

Definition.

1. Starch sugar or grape sugar is the solid product obtained by hydrolizing starch or a starch-containing substance until the greater part of the starch is converted into dextrose. Starch sugar or grape sugar appears in commerce in two forms, anhydrous and hydrous. In the former the sugar is crystallized without water of crystallization; in the latter it is crystallized with water of crystallization. The hydrous varieties are commonly known as 70 and 80 sugars; 70 sugar is also known as brewers' sugar, and 80 sugar as climax or acme sugar.

Standards.

(*a.*) Standard 70 sugar or brewers' sugar is hydrous starch sugar containing not less than seventy (70) per cent. of dextrose and not more than eight-tenths (0·8) per cent. of ash.

(*b.*) Standard 80 sugar, climax or acme sugar, is hydrous starch sugar containing not less than eighty (80) per cent. of dextrose and not more than one and one-half (1·5) per cent. of ash.

(*c.*) Standard anhydrous grape sugar is anhydrous grape sugar containing not less than ninety-five (95) per cent. of dextrose without water of crystallization and not more than eight-tenths (0·8) per cent. of ash.

The ash of these standard products consists almost entirely of chlorides and sulphates of lime and soda.

Definition.

2. Glucose, mixing glucose, or confectioners' glucose is a thick syrupy substance obtained by incompletely hydrolizing starch or a starch-containing substance, decolorizing and evaporating the product. It is found in various degrees of concentration, ranging from forty-one (41) to forty-five (45) degrees Baumé.

Standard.

Standard glucose, mixing glucose, or confectioners' glucose is colourless glucose, varying in density between forty-one (41) and forty-five (45) degrees Baumé, at a temperature of one hundred (100) degrees F. (37·7° C.) It conforms in density, within these limits, to the degree Baumé it is claimed to show, and for a density of forty-one (41) degrees Baumé contains not more than twenty-one (21) per cent. of water and for a density of forty-five (45) degrees not more than fourteen (14) per cent. It contains on a basis of forty-one (41) degrees Baumé not more than one (1) per cent. of ash, consisting chiefly of chlorides and sulphates of lime and soda.

Definition.

3. Glucose syrup or corn syrup, is glucose unmixed or mixed with syrup or molasses.

Standard.

Standard glucose syrup or corn syrup is glucose syrup or corn syrup containing not more than twenty-five (25) per cent. of water nor more than three (3) per cent. of ash.

(c.) CANDY.

Definition.

1. Candy is a product prepared from a saccharine substance or substances, with or without the addition of harmless colouring, flavouring, or filling materials.

Standard.

2. Standard candy is candy containing no terra alba, barytes, talc, chrome yellow, or other mineral substances or poisonous colours or flavours or other ingredients injurious to health.

THE WEST INDIA COMMITTEE'S BANQUET TO SIR NEVILE LUBBOCK, K.C.M.G.

(Continued from page 19.)

The Duke of Marlborough, Under Secretary of State for the Colonies, was the next speaker. He began by mentioning that he had been one of those who had been invited to join the party of British M.P.'s that had gone to Paris to be the guests of the French Republic, but having also had an invitation to this banquet, he had preferred to accept the latter offer. He then turned his attention to the West Indies. "I have the honour," he said, "to be the Under Secretary at the Colonial Office (hear, hear), and I know, I think it is for a century or a century and a half, that the Colonial Office have been in constant communication with the West India Committee. And I think I may say further, that during the time that your President, Sir Nevile Lubbock, has occupied the post that he holds, the relationship between the Colonial Office and the West India Committee has never been more cordial, more in harmony, and more in friendship altogether than it has been during those years. (Cheers.) Gentlemen, I think I may say, may I not, that during the nineteenth century all our Colonies have developed and prospered in a most remarkable degree. This prosperity has been the source of the greatest satisfaction and joy to every Englishman, but I do not know that in saying this I can altogether include the West Indies. Their prosperity at times has been great; at other times it has not been so, and indeed during the last ten or twenty years I think it is no exaggeration to say you can hardly call the condition and the state of the industries in the West Indies as entirely prosperous. Well,

gentlemen, what are the causes of this? I think they are two-fold. On the one hand there are causes over which we have no control. (Hear, hear.) Now, we have no control over such untoward and unfortunate events as an eruption in St. Vincent; we cannot possibly control the hurricanes that have taken place in the years 1898 and 1899, and only recently this year in Jamaica. We have to regard them as unfortunate occurrences which the West Indies are subjected to, and alas! we ourselves can do very little to prevent them. But whenever these unfortunate occurrences do take place, bringing a great deal of misery and loss of wealth to the inhabitants of the West Indies, we find that immediately the very first people who come forward and are prepared to help them are the West India Committee (cheers), and I think I am right in saying that in spite of the hurricane in Jamaica which has recently taken place, my friend Sir Alfred Jones has still maintained his line of ships without any interruption. (Hear, hear.) So much for those things over which we have no control. Gentlemen, what about those events over which we have some control? What sort of relationship do you think should exist between the Colonial Office and the West Indies in these matters? I think it should be something similar to a pair of scissors; each part of the scissors goes its own way; occasionally the parts go in opposite directions, but they always punish anything that comes between them. (Cheers.) And I think this is true of the relationship of the Colonial Office with the West Indies. We have tried—I will not say punished, that would not be perhaps the correct term—to remove the difficulties which have come between us and the West Indies. As an illustration, Sir Nevile Lubbock has pointed out that now we have succeeded at last in removing the bounty system which has prevailed in Europe; the system of bounty-fed sugar which has gone on I think for over 25 years, which every successive Government in England had done their best to get quit of, but had never been able to succeed, and it is only in the present time when, to use the words of Sir Nevile Lubbock, the Government stiffened their backs that we have been able to have a Conference to get these undesirable sugar bounties done away with. Now, gentlemen, I say that our opponents—the opponents to the Sugar Convention—are still making reflections upon it. They do not seem to be very happy. I see they are still putting forward this conundrum—it is practically a conundrum. They say that if the price of sugar goes up as a consequence of the Convention, it is indeed very hard upon the consumers in England that they should have to pay a dearer price for their sugar in order to benefit the West Indies. If the price of sugar does not go up, how do you propose to benefit the West Indies at all? Well, gentlemen, I admit this is a conundrum, but like many other conundrums, I think it is possible to be solved. We say we do not believe that the price of sugar will go up as a result of the Sugar

Convention above the average price of sugar during the last ten years. (Hear, hear.) In fact, I think I am right in saying that the price of sugar at the present time is 1s. less per cwt. than the average price of sugar for the last five years. There is this other consideration attached to the Sugar Convention: everybody who is growing sugar in the West Indies now knows for certain that this unfair competition that existed in the past has been effectually removed. If I may use a sporting and pugilistic expression, they know that the Queensbury rules will be observed, that the ring is a fair one, and that the fight will be conducted on just and fair and open lines. (Cheers.)

"Sir Nevile Lubbock referred to other industries in the West Indies, and I hope you will allow me before I sit down to remind you—you know it only too well—that there are other things we can grow there besides sugar. We can do, I believe, a great deal in the production of that most necessary article for the British manufacturers —cotton. I believe I am right in saying—I hope you will correct me if I am wrong—that in the beginning of the eighteenth century the West Indies supplied an enormous quantity of cotton to the British market—some millions of bales per annum. And I think that during the American Civil War they did the same also. If they were able to do that then, why should they not be able to do it to-day? When Lancashire requires all the raw material she possibly can get, why should we not do all we can to develop in the West Indies, in those tracts of country which are uncultivated, a growth of cotton for the Lancashire market. (Cheers.) I know there are several distinguished cotton people here this evening. They will tell you that the shortage of cotton for Lancashire this year amounted to something like half a million bales of cotton. (Hear, hear.) They have got to get that somewhere; if they fail to get it, it means that their manufacturing industries must deteriorate, and eventually the work that they are now doing will pass into the hands of foreign countries.

"And there is another matter in connection with this Lancashire industry. It has become more and more a specialised industry. They require the best kind of cotton that can possibly be grown, and as I understand it, there is no better place in the world where the long staple seed cotton can be grown than the West Indian Islands themselves. I had a letter the other day from Sir Gerald Strickland, whom I dare say many of you know well, and he told me they were doing all they could for the development of the cotton industry in the islands over which he governed, and that he hoped in the future he would make this industry a success, and he told me further, that in Montserrat sea island cotton had been sold for £14. Well, gentlemen, I believe it does not cost more than £4 an acre to grow cotton, and if you can make £14 an acre I think there is a fair field and a good opportunity for somebody to make an honest and profitable livelihood.

I think there is an almost historic prejudice against the growth of cotton in the West Indies. Probably in the past people may have lost large sums of money by it, but we believe the conditions of to-day are not those of former times. We have now, in the West Indies, the Imperial Department of Agriculture, which did not exist before; we have Sir Daniel Morris at the head of it, who is prepared to give his advice and experience to those who are interested. We have admirable fast lines of steamers, which formerly did not exist, and last, but not least, we have the British Cotton Growing Association. With these different factors which are existent to-day, and which were not apparent in former years, I see no reason why, in conjunction with the production of sugar, the growth of cotton should not be again re-established in the West Indies, and that the combination of these two industries together may in the future restore to the people of the West Indies their prosperity and their old success, and that those years of depression and anxiety may now be removed, and that once more among all the King's dominions we may look forward to the West Indies being as successful, as prosperous, and as joyous in the future as at times they have been in the past." (Loud cheers.)

After speeches from Sir Cuthbert Quilter, Bart., M.P., M. Yves Guyot (who replied in French to the toast of "Our Guests"), and Sir Alfred Jones, the Chairman terminated the proceedings with some appropriate remarks.

DR. MAXWELL'S WORK IN QUEENSLAND.

On the 17th October last Dr. Walter Maxwell, Director of the Sugar Experiment Stations in Queensland, held his annual field day at the principal station in Mackay. A large gathering of some 140 cane farmers assembled, and had ample opportunity for inspecting the station, and interviewing Dr. Maxwell. The latter addressed the assembly in the course of the day on the work of the Bureau. We are indebted to the Mackay *Sugar Journal* for the accompanying account of the proceedings :—

"Entering the experimental grounds proper, by the small gate near the laboratory, the visitor at once comes to the experimental plats for testing cane varieties. The *modus operandi* has been as follows. There were some hundred varieties originally, and these have been grown and replanted not less than three times on the station, in order that they may get acclimatised. Dr. Stubbs, of the Louisiana Sugar Experiment Station, laid it down as a sound rule that until cane had been planted in Louisiana five times it could not be considered acclimatised. The value of acclimatisation, and the necessity of it, if exact results are to be obtained in testing canes, is or should be sufficiently obvious. An unacclimatised cane might

give bad results the first year and then be thrown out, before ever it had a chance of proving its real value when brought into correlation with its environment. On the other hand, again, a new cane might give reasonably satisfactory results a first year, but might deteriorate in its new surroundings, and thus cause disappointment and loss, where success, on the first year's result, was apprehended. In the course of acclimatising the hundred varieties at his disposal, Dr. Maxwell threw out some thirty, as giving such poor results as not to warrant any further expenditure upon them. As to the balance, numbering 68 in all, these have now been acclimatised and planted out, and in due course, when the results are known and further selections are made, probably another 30 at least will be discarded. Of the 68 varieties, 43 are planted on the western side of the station, these being the double tests, with irrigation and without, and the balance of the varieties are planted on the east side of the station, these being only intended to form single tests, without irrigation, of the value of the different kinds. Almost without exception these latter canes are New Guinea sorts, of which there was only a small supply of seed.

"Each variety, on the double test plats, is planted in two rows, irrigated, and in two rows, non-irrigated. Of course the best of cultivation and the same manures are employed, and in every way the cane has practically the same treatment, except as regards the artificial supply of water. It may be said here that, quite unintentionally apparently, at the present time these test plats afford one striking lesson namely, of the value of thorough fallowing. It so happens that the cane on the non-irrigated plats, is on ground which while chemically the same as the irrigated plats has been fallowed twice, with the result that the young plants have come away more rapidly, and at the time of our visit actually looked, on the whole, rather better than the irrigated cane. Each plat of varieties is numbered, and the name or number of the cane given. Walking along the headland one is struck by the variations in the canes coming on, even at this early stage of their development. Indeed there is remarkable uniformity about each plat, which lends emphasis to the variations betwween the different plats. Amongst the 43 sorts of canes which constitute the main variety experiment, we noted varieties from widely distant countries. Queensland and New Guinea sorts were of course there. Louisiana supplied varieties, and South Africa also had a representative. Demerara and Trinidad seedlings were there, and Mauritius and the Sandwich Islands also had their representatives. At this stage it would be unwise, even were it at all possible, to hazard a guess as to which of these many varieties will come out on top, in the race which has just been started, but it should be noted with emphasis that all the sorts start fair, none is handicapped, either by lack of acclimatisation, or by different

treatment, or diversified soil conditions. When one realises this, he is naturally struck to see some varieties strong, green and vigorous, and a few, not many happily, poor, wilted, dead and dying, with a poor chance, if any, of getting to the end of the race. Such observations as may be made in the irrigated lines are found duplicated with exactitude in the non-irrigated lines, showing that the application of water is not to blame or accounts for any bad results, while the fact that the land analysed the same, and the treatment throughout has been similar, is sufficient to justify the conclusion that one must look to the individual plant itself for the cause of such failures as may occur. Clearly here the agricultural or climatic factors cannot be called to account, and what is required is a competent entomologist or pathologist to discover what there is, in certain varieties of cane, to make them fail, where others uniformly succeed. A few observations as to the present behaviour of some of the varieties may be of interest, though, as we have already said, nothing now stated must be taken as final. The cane is only from twelve to twenty inches above the soil. It is somewhat of a surprise to find that Chenoma, a popular cane in some parts of the Mackay district, is doing badly, though it appears to be making a good fight for its life. We were informed that the utmost care was taken in selecting all seed, and the natural explanation of gummed sets did not apply. The White Bamboo also looks very poorly, while our old friend the Bourbon appears absolutely unable to recover the high position it at one time held in the opinions of planters in Queensland, before the great rust epidemic of the latter seventies. Two Louisiana canes, of which it has already been said in this paper that they flowered early in the season in Mackay, whereas they have never been known to flower at all in Louisiana, are looking strong and healthy, and encourage the hope that we may find an early maturing cane of vigorous growth and good sugar production. The famous 74 D., a seedling, is doing well, and possibly may live in Queensland to repeat its feat in Hawaii of producing 24 tons of sugar to the acre. Two Trinidad seedlings are looking well, but one, No. 202, shows up almost as badly as the Bourbon. Another Demerara cane, which is not looking too well, is maintaining an unenviable reputation which it secured for itself in the Sandwich Islands. The Yuban cane, all the way from South Africa, is a particularly strong and healthy looking variety and stools out enormously. This is one of those varieties which will require further experimentation later on, before the best intervals of planting are arrived at. Of the New Guinea varieties there is a great number, some looking excellently, and others appearing weak. However the race in cane growing is not always to the strong. The tests, which these experiments cover, are not limited to the mere finding out of the number of tons of cane any given variety will produce. The amount of sugar yielded per acre is also to be determined, and experience has

shown that as a general rule the lighter canes are the richer in sugar, consequently some of the less vigorous growths may be found in the running, when the station has to declare which are the best canes to combine weight for the farmer and sugar for the factory. As we have already written, of the varieties on the east side of the station there is not much to be said. They are not irrigated and do not enter into direct competition with those to which we have been referring as planted on the west side.

"The farmers accompanied Dr. Maxwell round the station. He explained that the cane planted to test the varieties was put into the ground in the first week last August. The test of irrigated against unirrigated varieties was intended to secure, as the Americans would say, sorts that would buck against the dry weather. All the cane had been treated alike, the land being ploughed to a depth of 12 inches, cross-ploughed and sub-soiled, and subsequently treated with the same manure. The non-irrigated cane had the slight advantage of being on land which had been fallowed for a longer time than that on which was the irrigated cane, and they saw the effect in the plants' advanced state of growth. This was important in the first place as showing the advantage of thorough fallowing. The cane came away slightly ahead of that on the land which had not been so much fallowed, and it was still slightly ahead though he expected the other cane would soon overtake it. The advantage thus gained showed the value of deep and thorough cultivation. In the varieties making a poor show it was clear that the fault lay not with the soil or the climate, but with the plants themselves.

"Of the experimental plats, which formed the principal subject matter of last year's field day, there is now something definite to be said. As will be remembered Dr. Maxwell laid out as his initial experiments the following:—He planted with and without manure two plats, alleged to be cultivated much as the average farmer cultivates, though the farmers generally admit that the work was done better than is customary. The land was fairly well ploughed but was not sub-soiled. Opposite these plats were sub-soiled plats, one grown with manure and one without, corresponding with the farmers' unsub-soiled plats. None of the cane was irrigated. It was planted last April twelve months, and consequently is about eighteen months old. It is now being harvested. The comparative results are given, but it should be clearly and distinctly understood that these plats cover a considerable amount of ground, that the various results are found to coincide with unvarying regularity, and that none of the operations of farming are such that any hard working farmer with suitable implements could not perform for himself on field scale. The results of sub-soiled and thoroughly cultivated land, and land which had not been so treated was sufficiently striking to arrest the attention of every farmer, especially when it was remembered that

the soil of the station, on analysis, had been found to be not above the average of ordinary fair soil in this district, that there had been no irrigation, and consequently the cane had last summer to battle through on the moisture it could draw up from the sub-soil, and, last but by no means least, that, despite the extra expense of working on a small scale, with all the exactitude necessary for experimental purposes, the crop was shown to be produced at a profit, considerably in excess of that which the ordinary farmer ever hopes to make out of his own cane cultivation. In addition to the tests between what may be called farmers' and station cultivation, there is now practically completed, after the rest of the cane has been cut, a series of trials with different manures, the cane being treated alike in every phase of cultivation and fertilisation, but of each pair of corresponding plats, one is irrigated after the Hawaiian method, and the other has to trust entirely to nature for its moisture. At eighteen months of age the unirrigated cane had yielded 48·5 tons of cane to the acre, taking the average of all the plats, while at twelve months the irrigated cane had averaged 43·8 tons to the acre. The ratooning which is now commencing will give both crops a fair start and an even one, though certain of the plats will be held back to secure a further trial, to ascertain if by cutting late it is not possible to secure a ratoon crop that will hold right over from the latter end of one crushing to the beginning of the harvest eighteen months later. The experiments will also serve to demonstrate to some extent the wisdom and profit of short crops and long ones.

"In the course of his discussion with the farmers Dr. Maxwell again explained in detail the cultivation and other operations put into each plat. The plats cultivated, without deep ploughing and sub-soiling, gave an average of 29·6 tons to the acre, as against 49·6 tons, where thorough cultivation was employed but without irrigation. The exact cost of production of all these plats he would give later on. He explained again the Hawaiian method of irrigation, and in reply to an interjection, said that the farmer from whom he bought the Rose Bamboo sets last year had told him that he (the farmer) had planted cane from similar sets and had only got ten tons to the acre, yet on the station they had got nearly 50 tons to the acre. The farmer who was present corroborated this. Dr. Maxwell further pointed out that the rebate alone on the thoroughly cultivated plats amounted to £11 an acre. Coming to No. 9 plat he pointed out that here the soil was some six inches shallower than on the rest of the ground. As anticipated the effect of this was seen in the returns, and they found that there was an immediate drop from 50 to 40 tons in the yield, reproducing itself in a lesser degree in the corresponding plat, where the depth of the soil was somewhat better. This again emphasised the advice he had given last year to farmers to test the depth of soil, before going on to the land, and he referred to the fact

that it had been found that farmers, desiring to take up land at Farleigh, had thought it well worth their while to take spades with them, to test the soil. If the soil was shallow all the manures in the world could not help them beyond a certain point. By thorough cultivation they might, after several years, increase the depth of their soil, but if it were possible he advised them to take up deep soil land at once, rather than spend many years in making shallow soils deep. Referring to the manurial experiments, Dr. Maxwell pointed out that the land on the farmer's plat had been in previous years gorged with manure, and consequently the manure had had very little effect, indeed it would be found not to have paid for itself. In the deep cultivated plats where irrigation was used the moisture had got to work straight away on the manures, while eight months' drought in the non-irrigated plats had left the manures untouched. Hence the manures showed better results on the irrigated than on the unirrigated plats. The various plats had received different applications of manures, some getting nitrogen, phosphoric acid and potash, and some only one or more of these elements. The results would be published in full in his report for the year. He might, however, tell them that the experience showed that practically no good was secured from the application of phosphates without nitrogen. This bore out the opinion given by him to Mr. Swayne, who secured the analysis of certain manures, which were being largely used by the farmers. He told him that the manures would not pay for their freight, and compounded a fresh manure for him, raising the nitrogen and potash and reducing the phosphates. The same manure was applied at the station, and the truth of the opinions he expressed to the farmers was written in the experiment plats before them, so that they could see for themselves. With nitrogen they got 50 tons to the acre, and immediately nitrogen was left out of the fertilizer they secured only $35\frac{2}{5}$ tons to the acre.

"After having briefly inspected the other variety plats, attention was directed to the sorghum and subsidiary cultivations. The crop of cassava was discussed, and the Director urged farmers not to feed their horses and stock upon it too freely, without first of all boiling the roots to get rid of the prussic acid which they contained. The rape corn planted last year yielded 56 tons to the acre, a greater crop by 20 tons than he had ever seen in the old country. He briefly pointed out the plats where six American and one Queensland varieties of sorghum were growing in competition, to see if they could not get better results than those obtained at present with the sorghum now cultivated. In this case it was noticeable that the American sorghums were making far the best show. Here also he warned farmers against too freely feeding stock on sorghum, until it had begun to seed, when the prussic acid disappeared. The maize crop had failed last year with the aphis, but he expected to grow

maize to ripen early in the winter next year. Then he would, he hoped, show them his piggery. The turnip crop was briefly discussed, and attention was then directed to the planting tests, enumerated above.

"CANE PLANTING TESTS.

"Another interesting and important series of tests are being made with Rose Bamboo cane, the object being to arrive with some degree of definiteness at the best intervals for rows, and the best distances apart for the sets. There are in all twelve plats, with three rows in each. Tests are being made with rows 4 ft., $4\frac{1}{2}$ ft., 5 ft., $5\frac{1}{2}$ ft., and 6 ft. apart, while the second question will be answered by cane planted in rows 5 ft. apart, but as follows: (1), two continuous canes uncut; (2), one cane uncut; (3), two continuous canes, only cut into lengths giving three eyes, and the sets being placed within a third of an inch of each other; (4), the same as the last, only with one cane cut. Three other plats, planted with sets of three eyes each, test the advantage of putting in the sets 6 inches, 12 inches, and 18 inches apart, respectively."

Further discussions took place between Dr. Maxwell and the farmers on the cost of labour, ploughing, upkeep of horses, cattle, &c. It was mentioned that the work on the experiment station had all been done by white labour at white men's wages, and the price received for the cane was 15s. a ton, paid by the mill and including haulage, and 4s. 8d. per ton rebate for employing only white labour.

A vote of thanks was afterwards accorded to Dr. Maxwell, in which the farmers expressed their appreciation of the work of the Sugar Bureau in elucidating important questions concerning cane cultivation.

The following were the results of the experimental cultivation plats supplied by Dr. Maxwell:—

RESULTS.

	£	s.	d.
Average of all plats, manured and unmanured, ordinary cultivation, 29·5 tons cane per acre, at 19s. 8d. (15s. paid by mill, and 4s. 8d. bonus,) per ton..	29	0	4
Cost of production, including manures, harvesting, and rent and taxes	16	16	0
Profit on 18 months' cane per acre..	£12	4	4

No. 2.

	£	s.	d.
Average of all plats with deep ploughing, sub-soiling, 48·5 tons per acre, at 19s. 8d...	47	13	10
Cost of production	23	17	7
Profit on 18 months' cane per acre	£23	16	3

No. 3.

Average all plats, deep ploughing, sub-soiling, irrigation, 43·8 tons per acre, at 19s. 8d. per ton	43	1	6
Cost of production as above, including irrigation	27	19	6
Profit on 18 months' cane per acre	15	2	0

SUMMARY TABLE OF FINANCIAL RESULTS OF CROPS.

Methods of Cultivation.	Age of Cane.	No. of Experiment.	Value of Crop per acre.			Cost of Crop. per acre.			Profit of Crop per acre.		
	Months.		£	s.	d.	£	s.	d.	£	s.	d.
1. Ordinary cultivation.	18	3	29	2	1	16	17	0	12	5	1
2. Non-irrigated deep cultivation	18	21	49	6	2	23	18	10	25	7	4
3. Irrigation, deep cultivation	18	18	44	19	11	27	6	1	17	13	10

CANE-CUTTING EXPERIMENTS IN QUEENSLAND.

On the occasion of Dr. Maxwell's annual field-day in connection with his experiment stations on October 17th last, an interesting feature of the day's proceedings was a demonstration of the capabilities of Mr. Herbert Paul's mechanical cane-cutter. We cull the following description of it from the Mackay *Sugar Journal*:—

"The machine or apparatus he used needs little description. In principle it offers considerable hope that the problem of cane-cutting approaches solution, though it would be rash to say that a perfect machine has at last been invented. In place of the usual reaping devices, the inventor has adopted the principle of the sheep-shearing or boiler-caulking implements—a flexible tube and a hand tool, the latter being a cutter in the form of a 3 inch chisel. Compressed air in the tube enables the chisel to strike, say, twenty blows a second, and the possibility of cutting the cane, without human exertion, was demonstrated. Human intelligence, however, directed the tool, the operator having only to place the cutter against each stick, thus avoiding the heavy work of striking the blow. It remains for the apparatus to be perfected and fully developed. The difficulties are many, but there appear to be none not capable of being overcome. Thus, for instance, the power necessary for driving the cutters has yet to be decided upon. A portable oil engine, driving a compressor, was used in the tests on Saturday, but it is an open question whether the cutter operated by electricity might not give equally satisfactory

results, with greater convenience and more scope for working. Yet again, in dealing with a heavy crop, where the cane lies matted on the ground, the operator will have to work so that the canes may be cut in the face, being halved if necessary in order that the mass may be removed by the men collecting the crop for loading. With long stalks lying across several rows, it would be impossible for anyone to pull out the canes unless divided, and so disentangle them from the mass of growth. The weight of the tool, shown at the experiments, was altogether too great, but as it was made of unnecessarily thick steel, and could be made of aluminium, this objection should be easily overcome. It may also yet be found advisable to lengthen the tool, to minimise the stooping of the operator, but no lengthening which will necessitate the use of both hands is likely to succeed, as then the operator will be deprived of the use of the one hand, which is required to push back the canes and leaves, in order that fair scope may be given to the hand with the cutter. So far Mr. Paul has not attempted to demonstrate that he can top the cane, though this appears as possible as the cutting of the stalks at their bases. However, while a chisel may be necessary to enable cutting close to and into the ground to be carried out, the cutter for the tops or centres of the canes, where there will be little or no resistance, must be of different formation. A circular disc, with or without teeth, will probably be found necessary in this part of the work, and consequently we shall find the completed machine supplied with two sorts of cutters, one for tops and centres, and another for the butts of the cane stalks. One thing seems clear. Whether the cane is topped first and cut afterwards, or the reverse, it will be necessary that a considerable gang of men shall follow and at once remove the fallen cane out of the way, in order that the work may be carried on without interruption. The test was made under the most disadvantageous circumstances, that is to say, the crop was an untrashed fifty ton one, grown in furrows for irrigation, and lying on the ground in all directions. It presented probably the maximum of difficulties, which the operator is likely to meet, and such success as was accomplished means that the cutting of ordinary light crops, or crops through which a fire has gone, may now be regarded as a matter of certainty. One of the onlookers, with absolutely no previous knowledge of the tool, not only cut cane himself quickly, but was so well satisfied that he was prepared to try against a knife. The proposed cutter can with more power undoubtedly fell cane at a far greater rate than can the ordinary man with a cane knife, and with less exertion and personal distaste to the operator. This is something accomplished, and is in itself a distinct gain. If one man can now do the work of three, even if it be only a fractional portion of the operation of cane-cutting, then there is a distinct advance made, always assuming that the interest

on the outlay and the cost of working do not exceed that of individual human cutters. If, as seems comparatively easy, the topping can also be done in quicker time than with the knife, the gain is intensified. Further inventions which will assist in the rapid collection and loading of the cane will complete the revolutionising of harvesting in the cane fields. It may be found that the cheapest and best way to harvest cane with machines will be to let the work to contractors, who will take field after field, using their own machines, in much the same way that well-boring has for years past been carried on in the western country. If such eventually comes about, it is not unreasonable to hope that we shall find a very much more satisfactory supply of cane going to the mills, with a reduced loss from deteriorated cane, owing to its being left in the fields before delivery. Mr. Paul's invention is past its infancy, and its youth is one which gives promise of a robust manhood, and we venture to say that this is the first attempt at mechanical cane-cutting of which so much can be said. With the experience of this trial, the development of the machine should be rapid, and it is not impossible that mechanically cut cane will figure in our harvesting operations next year.

CENTRIFUGAL WORK IN THE SOUPPES USINE, FRANCE.

(From the *Journal des Fabricants de Sucre.*)

Amongst the chief improvements effected amongst sugar factory plant, those connected with the centrifugal department possess special features as regards economy. The substitution of malaxeurs for the masse cuite and mechanical feeding troughs of centrifugals in the place of the old flat troughs of great capacity (from which the masse cuite, hardened by rapid cooling, was taken up on shovels in the hands of robust workmen to be subsequently carried by hand to the centrifugals) is a sign of a great progress, in so far that it has tended to reduce hand labour and to carry out the work with greater precision, rapidity and nicety. Latterly this transformation in the method of working the cured sugar has been completed by the employment of helical conveyers, elevators, sifters, mixers, and sack-fillers—all working mechanically. Here again the dependence on hand labour has been still further reduced, and the work thereby accomplished more expeditiously and accurately.

But engineers and fabricants have never ceased their experiments; these have been directed towards the perfecting of other kinds of plant employed in the treatment of masse cuites; and in particular in increasing the efficiency and simplicity of the centrifugal as

regards starting, stopping, braking, emptying, etc. They have thus been led to construct centrifugal machines of large capacity, capable of being rapidly emptied underneath, driven by electric motor, or water power, attached directly to the spindle, and permitting one to dispense with all shafting, pulleys, belts, friction cones, and other accessories, involving a more or less heavy cost for maintenance. Thanks to the initiative of these progressive fabricants and of two of our best engineering firms, water driven centrifugals have come into use in several factories in France, notably at the Souppes (Seine et Marne) Usine. Having been recently invited to see this apparatus at work, we give below a short description of the installation at this usine.

In the first place we might mention by what methods the juices and syrups are treated at Souppes. This usine deals with 700 tons of beets per 24 hours. The juice coming out of the diffusion apparatus is heated with powdered lime (in the proportion of 1·5 kg. per 100 kg. of beets), then it is heated up to 60-70° C., passed into an electrolyser of zinc plates after J. Delavierre's system; it is next carbonated, re-heated, and passed through filter presses, the clear syrup is heated with powdered lime (200 gr. per 100 kg. of beets), re-heated, carbonated a second time, filtered in filter presses, then in Philippe filters, and evaporated in a quadruple effet—which is installed for multiple effet work—up to a concentration of 25 Bé. On leaving this apparatus the syrup traverses a Delavierre electro-lyser, then is heated up, passed through Philippe filters, and sent to the first sugar vacuum pan. The boiling apparatus is fitted with injectors of Delavierre's patent.

The boiling terminates at the end of eight hours, the masse is cooled in the malaxeurs, thence after fourteen hours' mixing it is transferred to the water-driven centrifugals to be cured. The masse cuite possesses at this point 12 to 13% of water. It yields on centrifugalling an extra crystallized white sugar, and both rich and poor runnings. The sugar, collected by a Kreiss conveyer placed beneath the machine and raised by a mechanical elevator, is mechanically transported to the magazine, where it is sifted, mixed in Thomas mixers, and finally packed in bags.

As to the centrifugal syrups, the weak runnings are returned to the first strike pan in the proportion of 50% to the masse cuite of pure syrup; the rich runnings are boiled to grain in the second strike pan, fitted with Delavierre injectors, where they serve to start the strike, the mixture being then increased by the addition of thin syrup which has not been returned to the first strike pan. The second strike masse cuite at the end of eleven or twelve hours' boiling is stirred in the crystallizers for four hours, then cured in four ordinary centrifugals. The resulting sugar is very slightly tinged russet colour, of good grain and polarizes at 96. It is re-melted directly in

second carbonatation juice. The centrifugal runnings (65-66 purity) are boiled to thread and cooled in tanks. It is to be noted that, thanks to the complete and thorough purification produced by the electrolysis of juice and syrups, the necessary amount of lime to be added does not reach 1 kg. 70° of anhydrate of lime per 100 kg. of beets. Consequently the lime kiln is of reduced size, only measuring 40 cubic metres. The proportion of coke used is about 8 kg. per 100 kg. of limestone. On the other hand, the purification of juices and syrups realized by this method of work is such that the massecuites obtained are of a light colour, very pure and very dry; and give a higher yield in first sugars.

Such is the general outline of the method employed at the Souppes factory. As to the hydraulic centrifugals, the special object of our visit, the following is the system under which they work:—The centrifugal is of the suspended Weston type, a system much used in the Colonies; but it has been modified by the firm of Watson, Laidlaw & Co., of Glasgow. The machine consists essentially of a basket or drum, of steel plate, perforated with cylindro-conical holes, supported by a vertical steel spindle about 2 metres long (6 ft. 6 ins.) The basket is 1 metre (40″) in diameter and 50 centimetres (20″) deep; it is furnished at its upper part with a lip of $140^{m}/_{m}$ ($5\frac{1}{2}$″), and its bottom has a clear opening for the discharge of the sugar. A cone of sheet steel, movable upon the spindle, allows of the closing of the bottom of the basket while running. Further, a cone of cloth is hung below the bottom of the basket, and, applying itself against the latter by the action of centrifugal force, prevents the air from reaching the drum during the spinning of the machine. The rotation is obtained in the following manner:—The spindle of the drum is hollow in its upper half; in this part is placed a second spindle which serves as the means of suspension: this rests at its upper end upon a ball bearing, while it carries a little lower down a system of rubber rings which permit the machine to balance itself. The outer spindle is fixed below the point of suspension to a wheel fitted with Pelton buckets, whose lower portion forms a pulley, and receives the action of a brake composed of wooden shoes and moved by an outside lever. The Pelton wheel is driven by a jet of water delivered at a pressure of 10 to 11 kilos per square centimetre (about 150 lbs. per sq. in.).

To effect this the motor is fitted with two nozzles having respectively diameters of $7^{m}/_{m}$ and $14^{m}/_{m}$ ($\frac{9}{32}$″ and $\frac{18}{32}$″), which communicate with a main pressure pipe into which water, slightly oiled (to prevent oxidation of the metallic parts of the centrifugal with which it comes in contact), is forced by a Tangye duplex pump. The steam cylinders of this pump measure $508^{m}/_{m}$ (20″) in diameter and $240^{m}/_{m}$ (10″) in stroke. The number of revolutions is 22 per minute. The pump draws the water from a suction tank of 22 hectolitres (484 imperial gallons) capacity, then forces it into air vessel provided with a

pressure gauge, and connected to a regulator for controlling the admission of steam to the steam cylinders, which regulates the speed of the pump so as to ensure the desired pressure at the jets of the hydraulic motors.

The water is then returned to the suction tank. As the water becomes heated gradually by its passage through the motors, it is necessary to cool it from time to time by the addition of fresh water.

The starting of the motor is very simple. The worker, with the help of a lever, opens the smaller nozzle, then the masse cuite valve on the feeding trough; as soon as the masse cuite reaches the top of the basket he opens the larger nozzle. The speed of rotation increases and soon reaches the fixed limit of 850 revolutions per minute; at this moment a very ingenious automatic governor moves a lever, and the larger nozzle is closed; the maximum speed is kept up by the smaller nozzle.

As to the washing, the worker, by the simple movement of a lever, admits into the basket a determined quantity of atomised water, forced by a pressure of air of 2½ kilos (35 lbs. per sq. in.); this is the moment when the separation of the runnings takes place. The operation finishes by a washing with steam, after which comes the stoppage of the centrifugal by closing the smaller nozzle and applying the brake.

The worker then proceeds to the emptying out of the sugar; for this purpose he raises above his head the cone placed at the bottom of the basket by passing it up the spindle to a hook on the upper part of the centrifugal, and with the help of a scoop he detaches the sugar lying against the perforated lining and makes it fall into the trough of a Kreiss conveyor arranged beneath the centrifugals. This done he replaces the cone on the bottom of the basket, and the centrifugal is ready for a new load.

The duration of the operation necessary to cure 160 kilos (350 lbs.) of extra white well dried sugar is, as follows, in minutes and seconds:—

	Mins.	Secs.
Charging	0	50
Accelerating	2	0
From the closing of the large jet until the washing with water	1	50
Washing with water	0	20
From the washing with water until the steaming	1	0
Steaming	2	30
Stopping (brake)	0	50
Emptying	0	40
Total	10 minutes.	

A load of 160 kilos (350 lbs.) of sugar completely cured in ten minutes.

At Souppes six turbines on the system just detailed have been installed. They only occupy an area of nine by three metres. Their output can easily attain to 1,000 sacks per 24 hours with only two attendants. The installation is one of great simplicity, and the running of the centrifugals is regular and absolutely silent. The work of the attendant, while heavy with the usual apparatus, is here of the gentliest and easiest kind imaginable, and it may be entrusted after a short apprenticeship to an unskilled man. The cost of lubrication is greatly reduced (40 kg. of oil have sufficed at Souppes for six centrifugals during the whole campaign), and the saving in hand labour achieved, thanks to the new installation, is such that the cost of centrifugalling, packing and shipping does not exceed 11 centimes per sack of sugar.

In conclusion, we have here a real and advantageous improvement not only for the manufacturer but also for the workman whose task is so much lightened. One must therefore congratulate M. André Ouvré on the new and remarkable progress which he has achieved in this way at his splendid usine at Souppes, showing as he does that he is anxious to keep in the van of progress; but it is only just to add that in this matter he has been skilfully seconded by his experienced and devoted managers, MM. Delavierre, père et fils.

THE INFLUENCE OF SOIL MOISTURE UPON THE CHEMICAL COMPOSITION OF CERTAIN PLANT PARTS.

By John A. Widtsoe.

The great variation in the chemical composition of plants grown under the same climatic conditions and upon similar soils, has always been a somewhat mystifying phenomenon to students of plant chemistry. That plant composition is influenced by soil composition is beyond question; and it is quite generally believed that sunshine, temperature and soil moisture are factors in controlling the chemical composition of plants. However, the relative and absolute values of these soil, climatic and water factors have not been determined, even approximately; and the observed variation in plant composition has usually been beyond satisfactory explanation. In view of this lack of knowledge, it was most interesting to find a definite relation between the soil moisture and the chemical composition of plants.

In a series of exhaustive experiments on irrigation, carried on by the Utah Experiment Station, the water applied to plants was definitely controlled, and the quantity so varied as to determine the most economical use of water in an irrigated district. All the plants grown in the experiments were subjected to chemical analysis. The full report of the work, in the summer of 1901, is published in

Bulletin No. 80 of the Utah Station, and it is upon some of the results there found that the present paper is based.

Soil Conditions of the Experiments.

The farm upon which these experiments were conducted is located on the old fossil delta of the Logan River, in Cache Valley, State of Utah. The soil is very shallow—varying in depth from 9 to 59 inches, with an average depth of 28 inches. Below this thin layer of soil is a porous bed, nearly 300 feet deep, composed of coarse gravel, with occasional streaks of sand. It is most probable that this condition of shallow soil, with very porous subsoil, was a strong factor in producing the observed variation in the chemical composition of the crops grown upon the farm. The soil layer is, in most respects, similar to the soils that prevail within the Great Basin Region, as shown by the following physical and chemical analyses. The methods of analysis followed were those prescribed by the Association of Official Agricultural Chemists.

Table I.—Physical Composition of the Soil.

Depth.	First foot.	Second foot.	Third foot.
Medium sand (0·1 to 0·5 mm.)	28·1	29·7	31·6
Fine sand (0·032 to 0·1 mm.)	25·6	26·4	29·6
Coarse silt (0·01 to 0·032 mm.)	19·2	16·4	14·6
Medium silt (0·0032 to 0·01 mm.)	10·2	6·6	6·6
Fine silt (0·001 to 0·0032 mm.)	2·6	5·6	6·5
Clay (below 0·001 mm.)	8·4	8·8	8·6
Moisture	4·7	4·3	1·8
Soluble and lost	1·2	2·2	0·7
Total	100·0	100·0	100·0

Average weight of one cubic foot of dry soil...... 88·9 lbs.

Average absolute water capacity .... 28·56 per cent.

Table II.—Chemical Composition of the Soil.

(All per cents. are referred to the water-free soil).

	First foot.	Second foot.	Third foot.
Insoluble matter	68·42	65·66	56·49
Potash, K_2O	0·65	0·57	0·43
Soda, Na_2O	0·55	0·53	0·60
Lime, CaO	6·07	8·20	14·81
Magnesia, MgO	5·13	4·13	3·32
Alumina, Al_2O_3	3·13	2·36	2·39
Iron oxide, Fe_2O_3	2·33	2·65	1·72
Phosphoric acid, P_2O_5	0·20	0·15	0·24
Sulphuric acid, SO_3	0·10	0·11	0·08
Carbon dioxide, CO_2	10·00	12·74	17·90
Organic matter	3·86	2·99	2·12
Total	100·44	100·09	100·10
Humus	3·72	1·18	1·06
Nitrogen	0·149	0·100	0·072
Water at 100 C.	1·85	1·91	1·69

The plats devoted to these experiments were one-twentieth of an acre in area, well ridged around the edges, so that the water applied would cover the ground to an approximately uniform depth. The depth of water applied at one irrigation varied, ordinarily, from 5 to 7·5 inches. All plants in the same experimental set were treated alike, except as to the quantity of water applied. The amount of water applied is expressed in the depth in inches to which the plats would have been covered had it been applied at one time.

Maize Kernels.

The maize used was of unknown name, but had been grown for many years on the Station farm. It was sown on April 30th, and throughout its life exhibited no extraordinary characteristics, save the variation due to the application of varying amounts of water. The ripe maize was harvested on September 11th. The maize kernels were analyzed with the following results:—

Table III.—Percentage Composition of Maize Kernels.

Irrigation water applied. Inches.	Water in fresh substance.	Water-free substances.				
		Ash.	Protein	Ether extract.	Crude fibre.	N-free extract
7·5	14·01	1·62	15·08	6·02	1·89	75·39
10·0	11·00	1·59	13·42	5·39	2·23	77·37
15·0	11·66	1·65	13·48	6·16	1·91	76·86
20·0	13·00	1·56	12·83	6·29	2·19	77·14
37·3	14·36	1·62	12·52	6·26	1·89	77·72

With one exception, the per cent. of water increased regularly with the increase in the amount of water under which the maize was grown. The per cent. of ash is not regularly affected by the quantity of water used. The protein content is strikingly influenced by the amount of water added to the soil. As the water increases, the per cent. of protein decreases—the difference between the protein content of maize which received 7·5 inches of water and that which received 37·3 inches being 2·56 per cent. The percentage of ether extract was also slightly affected by the soil moisture. As the water applied to the soil increases, the ether extract increases also.

The per cent. of crude fibre does not seem to be regularly influenced by the soil moisture, but the N-free extract tends to increase on the well-watered plats. In general, the protein in the maize kernel decreases with increased applications of water, while the ether extract and N-free extract increase.

Oat Kernels.

The variety of oats used in this experiment was "American Banner." The seed was placed in the ground on April 20th, and the ripe crop was harvested on July 30th. The composition of the oat kernel is shown in Table IV.

TABLE IV.—PERCENTAGE COMPOSITION OF OAK KERNELS.

Irrigation water applied. Inches.	Water in fresh substance.	Water-free substance.				
		Ash.	Protein.	Ether extract.	Crude fibre.	N-free extract.
6·98	8·00	3·26	20·79	3·91	9·02	63·02
13·20	7·73	4·52	17·29	4·19	10·76	63·25
14·89	8·11	4·97	15·48	4·21	15·40	59·55
30·00	8·40	4·49	15·49	4·59	10·92	64·51
40·00	8·62	4·55	15·80	4·56	10·38	64·71

As in the case of corn, the per cent. of water in the fresh substance is increased by an increased amount of water. The per cent. of ash does not seem to be affected by the soil moisture. As in the case of corn kernels, the relative amounts of protein are strongly affected by varying the amount of water applied to the soil. The larger the quantity of water, the smaller the per cent. of protein. The highest and lowest per cents. are 20·79 and 15·48—a difference of 5·31 per cent.

The per cent. of ether extract is highest in the well-watered plats, and the variation follows quite regularly the amounts of water used. The difference between the highest and lowest per cent. is 0·68. The highest per cent. of crude fibre is found on the plat receiving an intermediate amount of water. The N-free extract increases with an increase in the amount of water; this variation is regular, with one exception. As in the case of corn, increasing the water applied to oats, decreases the per cent. of protein, and increases the ether extract and N-free extract.

WHEAT KERNELS.

The variety of wheat used was "New Zealand." It was planted on April 13th, and harvested on July 29th and 30th and August 5th. Table V. shows the results obtained from the chemical analysis of the wheat kernels from the different plats.

TABLE V.—PERCENTAGE COMPOSITION OF WHEAT KERNELS.

Irrigation water applied. Inches.	Water in fresh substance.	In water-free substance.				
		Ash.	Protein.	Ether extract.	Crude fibre.	N-free extract.
4·63	7·70	2·70	26·72	2·37	5·44	62·77
5·14	8·16	3·32	25·11	5·24	3·05	63·28
8·81	8·25	2·96	21·25	3·63	4·38	67·75
10·30	8·47	2·54	19·93	2·09	4·47	70·97
12·36	8·14	3·12	22·18	2·12	4·31	68·27
17·50	7·59	2·79	18·57	2·34	5·88	70·43
21·11	6·80	2·50	16·99	1·97	3·92	74·62
30·00	8·70	4·50	15·26	1·85	3·19	75·20
40·00	8·01	2·72	18·43	1·94	3·42	73·48

There seems to be no regular variation in the per cent. of water, held by the fresh substance, to correspond with the amounts of water

applied to the soil; neither does the per cent. of ash show any definite connection with the soil water. The per cent. of protein increases very markedly in the wheat kernel as the amount of water applied to the soil decreases. The plat that received 30 inches of water yielded wheat containing 15·26 per cent. protein, while the wheat from the plat that received 7·70 inches contained 26·72 per cent.—a difference of 11·46. It is to be noted that the variation did not follow regularly the amounts of water used.

The variations in the ether extract are very irregular. The kernels raised with five to eight inches of water contain the highest per cents. of fat. The crude fibre is not strongly affected by the soil water, though the tendency is for the per cent. to decrease as the amount of soil water increases. The per cent. of N-free extract is highest in the wheat from the plats that received most water. As with corn and oats, increased watering of wheat decreases the per cent. of protein, and increases the per cents. of ether extract and N-free extracts.

Potato Tubers.

The variety of potatoes known as "Early Rose" was used in this experiment. They were planted on May 1st and 7th, and were dug on October 22nd. They were immediately sampled and subjected to chemical analysis. Traces of reducing sugar were found in all the samples, and a trace of sucrose in one sample. The quantitative determinations are exhibited in Table VI.

Table VI.—Percentage Composition of Potatoes.

Irrigation water applied. Inches.	Water in fresh substance.	In water-free substance.						
		Ash.	Protein.	Ether extract.	Crude fibre.	Starch.	Undetermined.	N-free extract.
8·08	76·00	6·68	11·83	0·55	2·69	69·95	8·30	78·25
10·00	76·34	4·57	12·57	0·11	2·46	69·55	10·74	80·29
15·00	75·54	4·85	12·52	0·33	2·21	72·58	7·50	80·08
20·00	76·24	4·29	11·46	0·50	2·56	76·25	4·94	81·19
27·00	75·95	4·99	10·77	0·06	1·93	75·10	7·15	82·25
39·99	76·00	4·87	8·33	0·79	2·06	76·48	7·47	83·95

It is quite noteworthy that the variation in the amount of moisture in the fresh potatoes is very small. In fact, the soil moisture seems to have little, if any, effect on the water content of potatoes. The per cent. of ash does not vary with the amount of water applied. As in the case of the grains, the relative amount of protein becomes larger as the irrigation becomes smaller. The one exception to this rule is the plat which received least water. The difference between the maximum and minimum per cents. is 4·24—sufficient to affect, materially, the food value of the potatoes. The variation of the ether extract is very irregular, and does not follow the variation in the amount of water applied to the soil. The crude fibre shows a

tendency to decrease on the well-watered plats. The per cent. of starch, on the other hand, increases very regularly with the increased irrigation. The difference between the highest and lowest per cents. of starch is 6·93—also quite sufficient to affect the food value of the tubers. The undetermined portion does not vary regularly with the soil moisture, but there appears to be a tendency for it to decrease as the watering becomes more liberal.

Sugar Beets.

The German Kleinwanzlebener seed was used in these investigations. Seeding was done on April 25th and 26th. The beets were harvested on October 22nd. The composition of the beets on the date of harvesting is shown in Table VII.

Table VII.—Percentage Composition of Sugar Beets.

Irrigation water applied. Inches.	Water in fresh substance.	In Water-free substance. Ash.	Protein.	Ether extract.	Crude fibre.	Reducing sugars.	Sucrose.	Starch.	Undetermined.	N-free extract.
12·32	76·23	4·76	9·68	0·29	5·37	1·22	60·85	6·33	11·51	79·91
15·57	75·95	5·14	8·15	0·31	5·24	1·17	63·20	6·33	10·43	81·13
17·64	75·34	4·38	10·51	0·32	4·80	1·24	61·62	6·19	10·96	80 01
20·06	76·46	4·89	10·42	0·36	5·06	0·94	60·83	6·91	10·59	79·27
21·00	78·67	4·98	7·50	0·18	6·02	1·53	57·21	7·46	15·12	81·32
25·31	75·69	4·69	8·98	0·36	4·98	0·64	62·93	7·10	10·13	80·80
40·82	77·58	4·69	5·63	0·45	5·68	1·18	62·01	7·05	13·31	83·55
53·96	73·39	3·79	6·10	0·36	4·79	1·89	60·65	7·07	15·35	84·96

The per cent. of water in the fresh substance does not vary, in general, with the variation in soil moisture. The per cent. of ash is irregular, and does not follow the soil moisture. The per cent. of protein tends to increase with increased applications of water, until 20 inches have been applied; from then on there is a distinct decrease. The difference between the highest and lowest per cent. is 2·92. The per cents. of ether extract, crude fibre, and reducing sugars are so irregular that they cannot well be connected with the variation in the soil moisture. The sucrose, which is the most important constituent of the sugar beet, constitutes from 57·21 per cent. to 63·20 per cent. of the water-free substance. Regular changes in the soil moisture do not seem to cause corresponding regular variations in the sucrose content. This is surprising, in view of the comparative regularity with which the nitrogen-free extract in the crops, previously studied, has increased with the increase in soil moisture. The per cent. of starch increases somewhat with the increase in soil moisture.

From these data, it would seem that the relative proportions of the constituents are not markedly affected by variations in soil moisture. The great regularity in variation that has prevailed in other crops leads to some doubt concerning the correctness of this view. The plats on which the sugar-beets were grown were very different in depth and in the proportion of gravel, and they had been manured differently. Further, the accurate sampling of beets is a matter of great difficulty. It must also be remarked that the beet was dried and ground before analysis, which is not the best method to be followed in making carbohydrate determinations in sugar-beets. While the per cent. of total carbohydrates may be very near the truth, the sucrose and other single constituents may have suffered change during the process of drying. These questions must be left, however, for future investigations.

To obtain fuller and more accurate data on the effect of soil moisture upon the sugar content and purity of the juice, the plats were sampled and the beets analyzed weekly, from August 19th to October 16th. The average results for the sugar in the juice are found in Table VIII.

TABLE VIII.—PER CENT. OF SUCROSE IN THE JUICE FROM SUGAR-BEETS.

Irrigation water applied. Inches.	August 19th to September 3rd.	September 10th to September 25th.	October 2nd to October 16th.
11·16 to 17·78	11·35	13·14	14·83
19·95 to 26·66	12·58	13·72	15·86
40·82 to 53·96	13·40	14·62	15·25

It is quite evident, from the above table, that during the first two periods, the per cent. of sugar in the juice increases with the increase in the amount of water applied. During the last period, the beets grown with more than 40 inches of water contain 0·61 per cent. less sugar than do those grown with an average of 23·31 inches of water. The general conclusion to be drawn from this table is, that increasing the soil moisture tends to increase the per cent. of sugar in the juice of sugar-beets.

TABLE IX.—PER CENT. PURITY IN JUICE FROM SUGAR-BEETS.

Irrigation water applied. Inches.	August 19th to September 3rd.	September 10th to September 25th.	October 2nd to October 16th.
11·16 to 17·78	77·0	77·9	81·1
19·95 to 26·66	80·6	81·1	82·7
40·82 to 53·96	80·5	82·7	84·2

Table IX. shows very clearly that the purity of the juice is highest with sugar-beets grown with large amounts of water, but that the differences are so small as to have little practical value.

Discussion.

A study of the preceding tables confirms the belief that the soil moisture influences strongly the chemical composition of plants and plant parts. To what extent the compositions of different plants and plant parts are affected by soil moisture cannot, of course, be determined from this preliminary investigation. However, it may safely be concluded that the protein and nitrogen-free extract are influenced more than any other chemical group contained by plants. It may further be concluded that withholding water from the plant increases the per cent. of protein, and diminishes the per cents. of nitrogen-free extract and fat; increasing the supply of water decreases the per cent. of protein and increases the per cents. of nitrogen-free extract and fat.

That the variation is far greater than that ordinarily assumed to be possible is shown by Table X., in which the differences between the lowest and highest per cents. of protein, fat, nitrogen-free extract and starch are given, due regard having been had for the variation due to the application of different amounts of water.

Table X.—Difference between Highest and Lowest Per Cents. due to Varying Soil Moisture.

Substance.	Protein.	Fat.	N-free extract.	Starch.
Corn kernels ..	2·56	0·90	2·33	—
Oat kernels	5·31	0·68	1·69	—
Wheat kernels ..	11·46	1·78	12·43	—
Potatoes	4·24	—	5·70	6·93
Sugar-beets	4·88	—	5·05	—

While the power to control the composition of plants by varying the soil moisture is of immense practical value to all irrigated countries, yet its higher theoretical importance must not be overlooked. To the plant physiologist it opens a large field of research, which promises to result in light been thrown on some of the obscure parts of our knowledge of plant growth and plant life. The temptation to theorize, even with the meagre data of this paper, is very great, but as considerable material on this subject has been gathered since 1901, the discussion of the physiological relations of the data, here presented, has been left for future reports. However, it may be said that the soil moisture is only one of many factors controlling the composition of plants, and that the great variations, recorded in this paper, were partly due to the peculiar soil conditions prevailing on the Station farm.

This investigation has been continued since 1901, and is still being continued.—(*Jour. American Chem. Soc.*)

PROCESS FOR REGULATING SUPERSATURATION IN THE BOILING OF PURER SUGAR SYRUPS, ESPECIALLY CONCENTRATED SYRUPS.

(Patent of Dr. H. Claassen.)

The present invention deals with a wider application of the process of Patent 117531. This latter is a process for regulating the supersaturation in the boiling of syrups by which under observance of the overconcentration that varies according to the purity of the syrups, especially mother syrups, the formation of grain and the further crystallizing out of the crystals in the pan is accomplished. By using the means and methods of Patent No. 117531, purer sugar juices, as for example the thick juices of raw sugar manufacture, or similar sugar solutions in the refinery, can now be treated. It is here however necessary, owing to the continually changing conditions of concentration, to ensure that a supersaturation of the mother syrups suitable for the formation of grain, and the enlarging of already formed grain, shall exist.

The boiling of these purer syrups to grain had been carried out hitherto after known methods, on the basis of the outward appearance of the boiling mass. It gave results which satisfied existing requirements when managed by skilful boilers. The regulation of the supersaturation by the outer appearance of the masse-cuite is, however, very imperfect even at the hands of an experienced boiler. Likewise boiling with the aid of known empirical figures as can be done when employed with the so called Brasmoscope, gives a very imperfectly regulated saturation of the masse-cuites.

In publications of the inventor in various papers in 1894-5 and 1897 tables of supersaturation figures were given which were based on experiences with the boiling of masse-cuite first products. They reveal how fluctuating are the conditions of supersaturation during similar periods of the boil, and between different boilings, notwithstanding the greatest attention on the part of the boiler.

These drawbacks are avoided, one obtains an even grain, and one is rendered independent of the uncontrollable skill of the boiler, if in the boiling of purer sugar solutions one employs the means and methods of patent No. 117531, and works by establishing and employing such quotients of supersaturation as are adapted for such juices. By the accomplishment of this process, the conditions of supersaturation at particular periods of the boiling are kept in uniform limits, and, furthermore, this occurs with the aid of control apparatus, by which one is in a position to estimate the required temperature and water-content for the desired supersaturation.

For the thick juices of beet-sugar factories, and juices of similar composition, given a purity of the juice of about 93 to 91, a supersaturation quotient of 1·35 to 1·45 is the most suitable for formation of grain. As soon as enough grain is formed under this supersaturation, it is altered to between 1·1 and 1·13, but never to less than 1·1. This latter point is based on the fact that owing to the lowering of temperature brought on by a changing vacuum, an under concentration and thereby a seizure of grain can easily occur.

In accordance with the falling purity of the mother syrups resulting from progressive crystallization, the quotient of supersaturation must be increased. This increase must take place slowly and uniformly during the boiling, attaining finally to 1·2, in order to avoid any formation of new crystals. With the attainment of this figure of 1·2, the boiling down begins. The object of the boiling-down (Abkochen) is essentially different to that of the foregoing boiling (Verkochen). By boiling down, the masse-cuite is prepared for further working up. To this object, the purity of the mother syrup, which was about 82 at the termination of the boiling, is reduced further as quickly as possible. Such an accelerated crystallization can only be carried out as long as the quotient of supersaturation is kept high, and, furthermore, so high that new crystals would form themselves if no agitated crystals (Anregekristalle) were present. Since the masse-cuite at the termination of boiling contains already about 50% crystals, these absorb nearly all the particles of sugar that will crystallize out, so that few, if any, new crystals form, and the existing ones are very little increased in size. The output of sugar and its quality are not affected by the formation of these new crystals during the operation of boiling down, since they are of little weight, and for the most part pass off through the sieve of the centrifugal. For that reason the acceleration of the crystallization through a high supersaturation quotient and the large amount of agitated crystals is very great. In an hour or two the purity of the mother syrup can be reduced from 78 to 75.

The boiling down begins, as above-mentioned, with a quotient of 1·2, and this quotient is raised by the falling purity of the mother syrup to 1·25, 1·30, and finally to 1·35, if boiled down with an addition of syrup (as described under patent 56867), in order to dissolve the fine grain present, and then crystallize it again with that in the masse-cuite.

If we stop boiling down on attaining a supersaturation quotient of from 1·3 to 1·35, then the masse-cuite is ready for working up into normal first product sugar.

The following table of water-content gives an example of how the boiling of thick juices and similar syrups can be carried out after this process:—

TABLE OF WATER CONTENTS FOR SUGAR SYRUPS OF HIGHER PURITIES.

Boiling Temperature.	During Graining		Immediately after Ggraining.		During Boiling.			When Boiling down.	
	Purity 91	Quot'nt 93.							
°C.	*a*	*a′*	*b*	*c*	*d*	*e*	*f*	*g*	*h*
67½	17¼	18	20¾	20¼	19½	18¾	18	17	16¼
70	16¾	17¾	20¼	19¾	19	18¼	17½	16½	15¾
72½	16½	17¼	20	19¼	18½	17¾	17¼	16¼	15¼
75	16	16¾	19½	19	18	17½	16¾	15¾	15
77½	15½	16¼	19	18½	17½	17	16½	15¼	14½
80	15¼	15¾	18½	18	17¼	16½	16	15	14¼
82½	15	15½	18¼	17½	16¾	16	15½	14½	13¾
85	14¾	15¼	17¾	17¼	16¼	15½	15	14	13¼

The employment of these tables cerresponds to the table of water-contents in Fig. 3 of the orginal patent 117531, only here the whole process of boiling can be completed in from six to ten hours, if normal first sugar is the desired object. The formation of grain follows here without any artificiality, and, moreover, of its own accord in the accurately thickening mass under motion. As soon as the formation of grain begins, one goes from column *a* to *b*, then from *a*¹ to *c* and boils after each of the rows *c*, *d*, *e*, *f*, for about one or two hours with gradual transitions, and afterwards the rows *g* and *h* if needed for an hour or two.

Boiling by the foregoing process results in as widespread as possible, a desugarizing of the mother syrups of the masse cuite, and a regular formation of grain—all in the shortest time.

Description of Patent: An alteration in the process patented under No. 117531, for regulating the supersaturation in the boiling of syrup, to wit, that when boiling purer sugar solutions or syrups, especially concentrated juices, the overconcentration following the graining (1·35 to 1·45) is fixed according to the scale of a special table of water content for sugar syrups of higher quotient of purity (91 to 93), whereby after the graining, to prevent the formation of new crystals, an altered overconcentration (1·1 to 1·13) is established, and consequently a systematic increase (corresponding to the falling purity of the mother syrup) takes place in the concentration up to 1·3 or 1·35, and lasts till boiling down commences.—(*Oesterreichische-Ungarische Zeitschrift für Zuckerindustrie.*)

THE FUTURE OF SUGAR IN MEXICO.

Mexico is not in a position to rely on the United States as a market for the consumption of its sugar, because in accordance with the Cuban treaty all the ports of the United States will be open to the free importation of Cuban sugar, and hence it can be delivered there in sufficient quantity to meet the demand at a lower price than that of any other country.

As is well known, the production of sugar in Mexico is controlled by a trust, which has concentrated the commerce of this article in a group of merchants whose object is to sustain the price of sugar in Mexico and export what cannot be marketed here at the price current. This would have probably given the results which were expected if the United States had left in force the tariffs by which sugars, whatever their points of origin, were assessed with the same duties. In that case it is clear that Mexican sugar could have relied on the United States market, as with a raise of price for home consumption they could sell their excess products at American ports at a lower price than the Cubans. But, from the moment that the treaty between Cuba and the United States specifies that Cuban sugar will pay at American ports less than that from any other point, the Mexican Trust cannot send its products with advantage to New Orleans or New York.

This matter would be of less importance if the excess production of sugar in Mexico was insignificant, or should remain stationary, but the fact of the matter is that at the present time new installations with modern machinery are being established, and large amounts are being invested in machinery, lands, plantations, &c., with the view of increasing the production.

Under these conditions, and with the American markets closed, the only way to find a market is by the exportation to Europe, especially England, or to South America, and the reduction of price in Mexico in order to increase consumption at home.

However, Mexico could hardly sell sugar in the English market in which the best sugar of France, Germany, Belgium, and Austria compete, which are nearer and favoured by the speculations of the Brussels Convention. Mexico, exerting itself, and even adopting the export premium policy, cannot with advantage dispose of its excess of sugar to England, and much less to the rest of Europe.

The drawback to the South American markets is lack of transportation lines, and until better facilities are secured the South Americans will have to consume sugar from other points, as the freight charges from here would increase the price to a very high figure.

There is but one way out of it, if it is desired that the sugar industry in Mexico suffer no sudden crash, and that is to lower the present price considerably in order to increase the home consumption.

The excess production which the Mexican sugar men complain about is a direct consequence of the increase in price of the commodity. Many people in various regions of the Republic do not consume refined sugar, but use brown sugar in cakes or soft brown sugar, due to the excessive price of the former.

The consumption of interior points will increase considerably as soon as transportation facilities are established in various parts of the country, and as soon as the economic situation of the lower class of people is improved; but this increase would be more rapid if the present price should be lowered.

It is a well-known fact that since sugar has gradually been going up, a large number of Mexico's poorer classes have ceased to use it, and others have reduced their consumption considerably. As soon as the price is lowered the consumption will increase rapidly.

There are industries in Mexico that would give excellent results that have not been developed due to the high price of sugar. For instance, the industry of fruit preserves, which has assumed such large proportions in other countries, would be specially productive in Mexico, where there are regions in which large amounts of fruit at present go to waste. The reduction in the price of sugar is the rational solution to the problem of any apparent overproduction of this article in Mexico, and the persons interested in the trust will not find another.

There is really no overproduction here, but merely an attempt by means of a combination to make worn-out and old-fashioned sugar mills pay when they should be torn down or rebuilt in modern style.

Sugar can be produced in this country and sold at a profit at little over one-half of its present price, and when this is done the increased consumption will furnish a market for not only all the sugar plantations now in operation, but many more. It is ridiculous that in Mexico, which is probably better adapted to produce sugar than any other country in the world, it should be sold at higher prices than in the United States where practically no sugar is produced and where there is a high duty on the importation of the crude article.

The actual consumption of sugar per head in the Republic is very small indeed, compared with that of other countries, or what it should be here. One hundred and fifty-five million pounds divided among fourteen million inhabitants gives an annual consumption per head of approximately eleven pounds. Whereas in France the annual consumption is about twenty-six pounds, in England about eighty pounds, and in the United States about seventy-five pounds.

In the last sixty years it is calculated that the population of the world has doubled, but the consumption of sugar has increased 800 per cent. The facts certainly show that a reduction in the price of sugar would make a home market for more than the actual or prospective production in this Republic, and still leave large profits in the business.—(*Modern Mexico.*)

Correspondence.

SAND FILTERS.

To the Editor of "The International Sugar Journal."

Dear Sir,—In your esteemed Journal for January appeared a notice about the success of sand filtration in the Racecourse Central Mill, Queensland. May I ask you to be kind enough to allow me to state through your columns, in order to prevent any confusion with other filters, that the two sand filters in question which gave such brilliant results are of "The Standard Type" but made in Australia. Considerable improvements have been made lately in the construction of the "Standard" with regard to capacity, durability and simplicity, so that the results stated in the Mackay *Sugar Journal* of 15th October, which you quoted in your notice will be largely surpassed in future.

Geo. Stade.

Berlin, 14th January, 1904.

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. Thompson, C.E., F.C.S., M.I.M.E., Chartered Patent Agent, 6, Lord Street, Liverpool ; and 322, High Holborn, London.

ENGLISH.—Applications.

27666. R. Harvey, Glasgow. (Communicated by Leon Naudet, France, and Henry Calverley Hinton, Madeira.) *Improvements in and relating to the treatment of sugar cane, beetroot and the like.* 17th December, 1903.

28296. E. Shaw, London. *Improvements in the treatment or preparation of sugar.* 24th December, 1903.

28297. E. Shaw, London. *Improvements in machinery or apparatus for use in the treatment or preparation of sugar.* 24th December, 1903.

28617. R. Harvey, Glasgow. *Improvements in and relating to evaporators for the treatment and concentration of cane juice, beet juice, and other juices and liquids.* 30th December, 1903.

28711. R. Harvey, Glasgow. *Improvements in and relating to evaporators for concentrating sugar cane, beet, and like juices or liquids.* 31st December, 1903.

28712. R. Harvey and H. Williams, Glasgow. *Improvements in or relating to evaporators for concentrating the juice from sugar cane or from any chemical liquors which require evaporation.* 31st December, 1903.

183. W. E. C. HOADLEY, London. *An improved process for th inversion of sugar.* 4th January, 1904.

ABRIDGMENTS.

23692. R. FÖLSCHE, Halle a/S, and F. NOWAK, Roswadze, Prussia. *Improvements in column shaped crystallisation vessels for sugar filling masses.* 2nd November, 1903. This invention relates to the process for crystallising out sugar products and securing a complete and uniform separation of the sugar in the centre of the mass as well as at the outside, characterised by the fact that the masses are submitted to a combined movement of their parts by means of a suitable device within a column shaped crystallisation vessel, the layers being preserved as well as possible in such a way that the portions of the mass are moved firstly from the circumference of the column towards the centre and secondly from the centre of the column towards the circumference.

26570. H. WINTER, Charlottenburg, Germany. *Improvements in and relating to the treatment of sugar juice.* 2nd December, 1902. This invention has reference to improved process of and apparatus for the treatment of sugar juices for first product and molasses in one operation. The essential feature of this invention consists in the combination of apparatus and process whereby sugar juices may be prepared in one operation for the final product and to obtain besides the final molasses (and without intermediate products) only one sort of sugar.

27014. J. G. HALL, Canonbury, London. *Improvements in portable furnaces for sugar pans and for other purposes.* 8th December, 1902. This invention relates to improvements in portable furnaces for sugar pans and for other purposes. In carrying the invention into practice, a cast-iron fuel chamber with a hopper shaped top having fire bars at the bottom is constructed. The inside of the fuel chamber is lined with fire bricks. In the hopper a shoot for charging purposes is inserted: this said shoot is tapered and placed at an angle and is provided with a loosely hinged flap inside to prevent the fire from coming out of the furnace when the mouth of the shoot is open. On the outside, the shoot is provided with a bend, having a sliding cover at the top: also an opening is made in the bend to poke the material into the furnace. Below the fire bars of the fuel chamber or furnace is a vertical air chamber to which is connected the end of a pipe from a fan for supplying compressed air through the air chamber to the furnace. A slide is provided at the base of the air chamber for holding the ashes.

GERMAN.—ABRIDGMENTS.

143710. FR. MEYER'S SON, Tangermünde. *Apparatus for sharply separating the drain in centrifugals.* November 29th, 1902. The centrifugal drum is enclosed by an annular casing divided into several

parts, the distance between the lower edge of the casing and the drum being variable, so that the lower edge of this casing down which the drain trickles, may be adjusted over different channels located under the drum.

143711. WEINMANN and LANGE, Gleiwitz, O.S. *An arrangement for automatically introducing liquids into vessels, more particularly into centrifugals, by means of nozzles.* December 2nd, 1902. On a shut off valve inserted in the feed pipe being opened, a pipe which carries the distributing nozzle is depressed into the centrifugal by the pressure of the liquid. After the valve has been closed, this pipe is withdrawn from the centrifugal by a counter weight.

144030. G. KÖGLER, Ilsenburg. *Press cone for shreddings presses with cells for discharging water.* October 12th, 1901. The press cone is formed of rings of suitable shape laid one over the other like a grate or spirally wound and allowing water to pass through, so that the interval between each two rings forms a drainage cell by means of which the water is conveyed to the middle of the press.

144326. HERM. HILLEBRAND, Werdohl, Westf. *Front knife for double shredding boxes for beet shredding machines.* April 2nd, 1901. The upper ribs of the front knife are provided with blade like projections at the side facing the rear knife. These blades cut into the part of the roots which is not in contact with the front part of the knife, and also prevent the roots being displaced laterally, and protect the rear knife from damage.

145177. ALPHONS HEINZE, Magdeburg. *Method of feeding shreddings conveyors.* December 28th, 1902. The shreddings coming from the diffusion apparatus and conveyed through the sludge gutter to the bucket conveyer frequently accumulate and heap up in front of the conveyor in such a way that they have to be loosened or dislodged by hand or by mechanical means, if the regular working is not to be interrupted. In the method described in this patent, one or more nozzles are inserted in the bottom towards the end of the shreddings sludge trough close in front of the conveyor, and through this nozzle (or these nozzles) a jet of a pressure medium is discharged into the trough in a direction inclined towards the direction of the sluicing, in such a way that the shreddings are loosened at the place where they are most liable to accumulate and their forward movement assisted.

145786. BROMBERGER MASCHINENBAU-ANSTALT, G. m. b. H., of Prinzenthal, near Bromberg. *A shreddings press having a straining casing or sieve tapering towards and contracted at its lower end, and at this place cylindrical parts of a spindle.* December 23rd, 1902. In order to prevent the shreddings being torn in the chamber, the lower cylindrical part is not made in one piece with the press spindle but separate therefrom, and is so arranged that it shares in the rotation of the press spindle.

146090. P. MEYER, Halle/on/S. *An evaporating arrangement without injection condenser and without an air pump, the first chamber of which is heated with waste engine steam.* March 8th, 1902. For the purpose of economising steam and simplifying the arrangement, the apparatus which consists of several evaporating bodies arranged one behind the other, is heated by the first body or chamber receiving engine steam at a suitable pressure. In this arrangement the liquid boils under a pressure which is greater than that of the atmosphere. The evaporating apparatus works without an injection condenser and without an air pump.

Copies of all published specifications with their drawings in these lists can be obtained from W. P. Thompson & Co., 6, Lord Street, Liverpool, at One Shilling a copy for English or American Patents, and Two Shillings for German. In ordering please give number and date.

The *D.Z.I.* calls attention to an organized system of saccharine smuggling between Switzerland and Germany, which has lately been detected. The post, rail transit, and cyclists have been the methods employed.

Mr. Harold Cox, Secretary of the Cobden Club, is stated to be about to resign his position. The Club will consequently lose a faithful and untiring servant, though one who too frequently allowed his zeal to outrun his discretion, as his letters to the press have repeatedly shown.

Mr. T. J. Pittar, C.B., Assistant British Delegate on the Permanent Sugar Commission at Brussels, has lately been appointed to succeed Sir G. L. Ryder, K.C.B., as Chairman of the Board of Customs. As there is every probability of that Board having a larger sphere of work to direct in the not distant future (in consequence of tariff reform) it is fortunate in possessing at its head a man of such broad-minded and progressive views as Mr. Pittar.

WEEKLY STATEMENT OF COMPARATIVE

For the last Fifty-two weeks compared

	German Beetroot 88 o/o Prompt, free on board.						French Crystals. No. 3. c. f. i.			West India. Good Brown.			Java afloat. No. 15 and 16.		
	1903.		1902.		1901.		1903.	1902.	1901.	1903.	1902.	1901.	1903.	1902.	1901.
Jan. 2..	8/1¾	8/0¾	6/6½	6/5¾	9/0¼	9/1	—	8/4½	10/6¾	—	—	—	9/4½	8/9	12/-
9..	8/0¾	8/-	6/5¾	6/5	9/1	9/3¾	—	8/2¼	10/8¼	—	—	—	9/4½	8/6	12/-
16..	8/-	8/1	6/5	6/7½	9/3¾	9/3¼	—	8/5¼	10/7½	—	—	—	9/4½	8/3	12/-
23..	8/1	8/-	6/7½	6/7½	9/3¼	9/1¼	—	8/5¼	10/8¼	—	—	—	9/4½	8/3	11/10½
30..	8/0	7/10½	6/7½	6/8¾	9/1¼	9/2½	—	8/7½	10/8¼	—	—	—	9/4½	8/3	11/10½
Feb. 6..	7/10½	7/10½	6/8¾	6/9	9/2½	9/3½	—	8/7½	11/-	—	—	—	9/4½	8/4½	11/10½
13..	7/10½	7/11¾	6/9	6/8½	9/3½	9/3¼	—	8/7½	10/10½	—	—	—	9/4½	8/7½	11/9
20..	7/11¾	8/2	6/8½	6/10	9/3¼	9/2½	—	8/9¾	10/9¾	—	—	—	9/4½	8/7½	11/9
27..	8/2	8/4	6/10	6/8	9/2½	9/2¼	—	8/7½	11/-	—	—	—	9/6	8/7½	11/7½
March 6.	8/4	8/4½	6/8	6/5½	9/2¼	9/0½	—	8/3	10/11¼	—	—	—	9/6	8/7½	11/7½
13..	8/4½	8/5¼	6/5½	6/3½	9/0½	8/11½	—	8/2¼	11/-	—	—	—	9/9	8/4½	11/7½
20..	8/5¼	8/3¾	6/3½	6/3¼	8/11½	9/0	—	8/3¾	11/1½	—	—	—	9/10½	8/-	11/7½
27..	8/3¾	8/2¼	6/3¼	6/6¾	9/-	8/11½	—	8/7½	11/-	—	—	—	9/10½	8/3	11/7½
April 3..	8/2¼	8/2¼	6/6¾	6/5½	8/11½	8/11	—	8/6	11/1½	—	—	—	9/7½	8/3	11/7½
10..	8/2¼	8/3	6/5½	6/5½	8/11	8/10½	—	8/5¼	11/3¾	—	—	—	9/7½	8/-	11/10½
17..	8/3	8/5	6/5½	7/2¾	8/10½	8/10	—	8/3	11/-	—	—	—	9/7½	8/-	11/10½
24..	8/5	8/4½	6/2¾	6/1	8/10	9/0½	—	8/1½	10/8¼	—	—	—	9/10½	7/9	11/10½
May 1..	8/4¼	8/4	6/1	6/3	9/0½	9/5	—	8/4½	11/7½	—	—	—	9/10½	7/9	11/10½
8..	8/4	8/3½	6/3	6/4¼	9/5	9/6	10/-	8/7½	Nom.	—	—	—	9/10½	7/9	11/9
15..	8/3½	8/4¼	6/4¼	6/4	9/6	9/7	10/-	8/6	Nom.	—	—	—	9/10½	7/9	11/9
22..	8/4¼	8/3¼	6/4	6/2	9/7	9/6¼	10/-	8/5¼	Nom.	—	—	—	9/10½	7/9	11/7½
29..	8/3¼	8/2¼	6/2	6/2¾	9/6¼	9/6	10/-	8/5¼	Nom.	—	—	—	9/10½	7/9	11/7½
June 5..	8/2¾	8/1½	6/2¾	6/2½	9/6	9/4	9/9	8/5¼	Nom.	—	—	—	9/10½	7/9	11/6
12..	8/1½	8/0¼	6/2½	6/3½	9/4	9/2¾	9/9	8/6	Nom.	—	—	—	9/7½	7/9	11/6
19..	8/0¼	7/11¼	6/3½	6/2	9/2¾	9/2¾	9/9	8/3¾	Nom.	—	—	—	9/7½	7/6	11/4½
26..	7/11¼	7/8½	6/2	6/-	9/2¾	9/3¾	9/9	8/2¼	Nom.	—	—	—	9/6	7/6	11/4½
July 3..	7/8½	7/9¼	6/2	*5/11½	9/3¾	9/3¼	9/9	8/0¾	Nom.	—	—	—	9/4½	7/6	11/4½
10..	7/9¼	7/10¾	5/11½	5/11¾	9/3¼	9/1¾	9/9	8/1½	Nom.	—	—	—	9/4½	7/9	11/4½
17..	7/10¾	7/11½	5/11¾	5/11½	9/1¾	9/6¾	9/9	8/3	Nom.	—	—	—	9/4½	7/9	11/4
24..	7/11½	7/11½	5/11½	6/0½	9/6¾	9/4	9/9	8/6	Nom.	—	—	—	9/6	7/9	11/4½
31..	7/11½	8/0½	6/10½	6/-	9/4	9/3	9/9	8/6	Nom.	—	—	—	9/6	7/9	11/4½
Aug. 7..	8/0½	8/2¾	6/-	6/-	9/3	8/10½	Nom.	8/6	Nom.	—	—	—	9/7½	7/9	11/-
14..	8/2¾	8/3¾	6/-	6/1	8/10¼	8/4¼	10/-	8/5¼	Nom.	—	—	—	9/9	7/9	10/10½
21..	8/3¾	8/5½	6/1½	6/1¾	8/4¼	8/3	Nom.	8/0¾	Nom.	—	—	—	9/10½	7/9	10/7
28..	8/5½	8/5¼	6/1¾	6/-	8/3	8/1¼	Nom.	8/0¾	Nom.	—	—	—	9/10½	7/9	10/4½
Sept. 4..	8/5¾	8/5½	6/-	5/11	8/1¼	8/0½	10/3¾	8/-	Nom.	—	—	—	9/10½	7/9	10/3
11..	8/5½	8/5¼	5/11	5/11½	8/0½	7/9¼	10/5¼	8/1½	Nom.	—	—	—	9/10½	7/9	10/3
18..	8/5¼	8/5¾	5/11½	6/1	7/9¼	7/7	10/5¼	8/3	Nom.	—	—	—	9/10½	7/9	10/-
25..	8/5¾	8/4½	6/1	6/3¼	7/7	7/5	10/3	8/4½	9/3¾	—	—	—	9/10½	7/9	10/-
Oct. 2..	8/4½	8/5¼	6/3¼	7/2	7/5	7/7¾	10/3	9/9	9/3	—	—	—	9/10½	8/-	10/-
9..	8/5¼	8/9½	7/2	7/1	7/7¾	7/7	10/3	9/9	9/1½	—	—	—	9/10½	8/-	9/6
16..	8/9½	8/9¾	7/1	7/2½	7/7	7/8¼	10/2¼	9/9	9/3	—	—	—	9/10½	8/6	9/3
23..	8/9¾	8/9¼	7/2½	7/7	7/8¼	7/4¼	12/2¼	10/3	8/9	—	—	—	9/10½	9/-	9/3
30..	8/9¼	9/6	7/7	7/6	7/4¼	7/1¾	10/2¼	—	8/6¾	—	—	—	9/9	9/3	9/-
Nov. 6..	9/6	8/7	7/6	7/5½	7/1¾	7/2¾	10/1½	--	8/6¾	—	—	—	9/7½	9/3	9/-
13..	8/7	8/6	7/5½	7/6½	7/2¾	7/3¾	10/1½	—	9/-	—	—	—	9/7½	9/-	9/-
20..	8/6	8/5¼	7/6½	7/10	7/3¾	7/4¼	10/1½	—	9/-	—	—	—	9/7½	9/-	8/9
27..	8/5¼	8/4½	7/10	7/11	7/4¼	7/3	10/1½	—	8/10½	—	—	—	9/4½	9/-	8/9
Dec. 4..	8/4½	8/4	7/11	8/2¾	7/3	7/1	10/1½	—	8/10½	—	—	—	9/4½	9/3	8/9
11..	8/4¼	8/4	8/2¾	8/4¾	7/1	7/1½	10/1½	—	8/10½	—	—	—	9/4½	9/3	8/9
18..	8/4	8/5	8/4¾	8/2	7/1½	6/10¼	10/3	—	8/9	—	—	—	9/4½	9/3	8/9
25..	8/5	8/4½	8/2	8/1¾	6/10¼	6/6½	10/3	—	8/6¾	—	—	—	9/3	9/3	8/9

* 5/10½ on July 2nd.

PRICES OF RAW AND REFINED SUGAR,

with those of the two previous years.

	Tate's Cubes. No. 1.			Tate's Cubes. No. 2.			First Marks German Granulated f. o. b.			Say's Cubes f. o. b.			German & Austrian † Cubes f. o. b.		
	1903.	1902.	1901.	1903.	1902.	1901.	1903.	1902.	1901.	1903.	1902.	1901.	1903.	1902.	1901.
Jan. 2..	18/3	17/6	16/-	17/3	16/9	14/9	9/4½	8/4½	11/-	12/-	11/-	13/-	11/3	10/4½	12/10½
9..	18/-	17/6	16/-	17/-	16/9	14/9	9/3¾	8/5¼	11/3	11/9	11/-	13/-	11/3	10/4½	13/-
16..	18/-	18/3	16/-	17/-	17/6	14/9	9/5¼	8/6	11/3	11/9	11/-	13/-	11/3	10/1½	12/10½
23..	18/-	18/-	15/9	17/-	17/6	14/6	9/3¾	8/6	11/1½	11/9	11/-	13/-	11/3	10/1½	12/9
30..	17/9	18/-	15/9	16/9	17/6	14/6	9/3	8/8¼	11/2¼	11/9	11/-	13/-	11/3	10/1½	12/9
Feb. 6..	17/9	17/9	15/9	16/9	17/3	14/6	9/3	8/8½	11/3¾	11/6	11/-	13/-	11/1½	10/1½	12/9
13..	17/9	17/6	15/9	16/9	17/-	14/6	9/4½	8/8¼	11/6	11/6	11/-	13/-	11/-	10/1½	12/9
20..	17/10½	17/6	15/9	16/10½	17/-	14/6	9/6	8/7½	11/6	11/6	11/-	13/-	11/1½	10/1½	12/9
27..	18/3	17/6	16/-	17/1½	16/9	14/9	9/7½	8/5½	11/6	11/6	11/3	13/-	11/4½	10/1½	12/9
March 6..	18/3	17/6	16/-	17/3	16/9	14/9	9/7½	8/-	11/1½	11/6	11/3	13/-	11/6	10/-	12/9
13..	18/3	17/6	16/3	17/3	16/6	15/-	9/7½	7/10½	11/-	11/6	10/9	13/-	11/6	10/-	12/7½
20..	18/3	17/6	17/-	17/3	16/6	15/9	9/7½	7/11¼	11/1½	11/6	10/9	13/-	11/6	9/10½	12/10½
27..	18/3	17/6	16/6	17/3	16/6	15/3	9/6	8/4½	11/0¾	11/6	11/-	13/-	11/6	10/-	12/10½
April 3..	18/3	17/6	17/-	17/3	16/6	15/9	9/6	8/2¼	11/-	11/6	10/6	13/-	11/6	9/10½	12/10½
10..	19/3	18/6	17/6	17/3	17/-	16/3	9/6¾	8/-	10/9	11/6	10/6	13/-	11/6	9/9	12/10½
17..	18/3	17/6	20/-	17/3	16/6	18/3	9/9¼	7/9¾	10/6	11/6	10/6	13/-	11/6	9/6	12/10½
24..	18/4½	17/-	20/-	17/3	16/-	18/3	9/10½	7/7½	10/7½	—	10/6	12/9	11/6	9/7½	12/9
May 1..	18/4½	17/-	19/9	17/3	16/-	18/-	9/11¼	7/9	10/10½	—	10/3	12/9	11/6	9/9	12/6
8..	18/4½	17/-	19/9	17/3	16/-	18/-	9/9¾	7/9¾	10/10½	12/1½	10/3	13/-	11/6	9/9	12/7½
15..	18/4½	17/-	19/6	17/3	16/-	18/-	9/9¾	7/9¾	11/-	12/1½	10/3	13/-	11/4½	9/7½	12/7½
22..	18/1½	17/-	19/6	17/-	16/-	18/-	9/9¾	7/9	11/1½	12/1½	10/3	13/-	11/4½	9/6	12/10½
29..	18/-	17/-	19/6	17/-	16/-	18/-	9/9	7/8¼	11/1½	12/-	10/3	13/-	11/4½	9/6	12/10½
June 5..	18/-	17/-	19/6	17/-	16/-	18/-	9/7½	7/7½	11/0¾	12/-	10/3	13/-	11/4½	9/4½	12/10½
12..	18/-	17/-	19/6	17/-	16/-	18/-	9/6	7/9	11/0¾	12/-	10/3	13/-	11/4½	9/6	12/10½
19..	18/-	17/-	19/6	17/-	16/-	18/-	9/4½	7/7½	11/0¾	11/10½	10/-	13/-	11/3	9/4½	12/10½
26..	17/10½	17/-	19/6	16/10½	16/-	18/-	9/3	7/6	11/0¾	11/10½	10/-	13/-	11/3	9/4½	12/10½
July 3..	17/9	17/-	19/3	16/9	16/-	18/-	9/3	7/4½	11/0	11/10½	10/-	13/-	11/1½	9/4½	12/10½
10..	17/9	17/-	19/-	16/9	16/-	18/-	9/5¼	7/4½	10/11¼	11/10½	10/-	12/9	11/2¼	9/4½	12/10½
17..	17/9	17/-	19/-	16/9	16/-	18/-	9/6¾	*7/4½	11/0¾	11/10½	10/-	12/9	11/4½	9/3	12/10½
24..	17/10½	17/-	19/-	17/-	16/-	18/-	9/6¾	7/6	11/-	11/10½	10/-	12/9	11/5¼	9/3	12/10½
31..	18/1½	17/-	19/-	17/3	16/-	18/-	9/10½	7/4½	11/-	12/-	10/-	12/9	11/6	9/3	12/9
Aug. 7..	18/4½	17/-	19/-	17/9	16/-	18/-	10/0¾	7/5¼	11/-	12/9	10/-	12/9	11/10½	9/4½	12/9
14..	18/4½	17/-	19/-	17/9	16/-	18/-	10/1½	7/6¾	10/9	12/9	10/-	12/9	11/10½	9/4	12/9
11..	18/6	17/-	18/9	18/-	16/-	17/9	10/3¾	7/6¾	10/7½	13/3	10/-	12/9	12/3	9/4½	12/4½
28..	18/9	17/-	18/9	18/-	16/-	17/9	10/4½	7/6¾	10/6	3,3	10/-	12/9	12/3	9/3	12/3
Sept. 4..	18/9	16/9	18/6	19/-	15/9	17/6	10/3¾	7/6	10/4½	13/3	10/-	12/3	‡	9/3	12/3
11..	18/9	16/6	18/6	18/-	15/6	17/6	10/3	7/6	10/2¼	13/3	10/-	12/3	‡	9/3	12/3
18..	18/9	16/6	18/6	18/1½	15/6	17/6	10/3¾	7/7½	9/9	13/3	10/-	12/3	‡	9/3	11/10½
25..	18/9	16/6	18/3	18/1½	15/6	17/6	10/2¼	7/9¾	9/6	12/10½	10/3	11/9	‡	Nom.	11/9½
Oct. 2..	18/9	17/-	18/3	18/1½	16/-	17/6	10/1½	8/3¾	9/5¼	12/10½	10/9	11/9	‡	—	11/9½
9..	18/9	17/-	18/3	18/-	16/-	17/6	10/1½	8/2¼	9/4½	12/10½	10/9	11/9	12/3	—	11/3
16..	18/9	17/-	18/-	18/-	16/-	17/3	10/1½	8/3¾	9/2¼	12/10½	10/7½	11/9	12/4½	10/3	11/1½
23..	18/6	17/3	18/-	17/10½	16/6	17/3	10/2¼	8/8¼	8/7½	12/10½	11/-	11/9	12/4½	10/6	10/10½
30..	18/3	17/3	17/9	17/9	16/6	17/-	10/2¼	8/6¾	8/3¾	12/10½	11/-	11/6	12/3	10/6	10/9
Nov. 6..	18/3	17/3	17/6	17/9	16/6	16/9	10/0¾	8/7½	8/3¾	12/10½	11/-	11/3	12/1½	10/6	10/6
13..	18/3	17/3	17/6	17/9	16/6	16/9	10/1½	8/8¼	8/7½	12/10½	11/-	11/3	12/1½	10/6	10/7½
20..	18/3	17/9	17/9	17/9	16/9	17/3	10/1½	9/0¾	8/11¼	12/10½	11/6	11/3	11/10½	10/10½	10/9
27..	18/3	18/-	18/-	17/9	17/-	17/3	10/1½	9/2¼	8/10½	12/10½	11/9	11/3	11/9	11/-	10/9
Dec. 4..	18/3	18/1½	18/-	17/9	17/1½	17/3	10/1½	9/7½	8/10½	12/10½	11/9	11/3	11/10½	11/4½	10/7½
11..	18/3	18/3	17/9	17/9	17/3	17/-	10/1½	9/9¾	8/10½	‡	12/-	11/3	11/9	11/6	10/7
18..	18/3	18/3	17/9	17/9	17/3	17/-	10/3	9/6	8/8¼	—	12/-	11/3	11/9	11/6	10/6
25..	18/3	18/3	17/9	17/9	17/3	17/-	10/4½	9/6	8/5¼	—	12/-	11/3	11/10½	11/6	10/6

7/3¾ on July 18. † Basis average Hansa FKL FMS. ‡ Not quoted.

H. H. Hancock & Co., 39, Mincing Lane, London, E.C.

IMPORTS AND EXPORTS OF SUGAR (UNITED KINGDOM,

To end of December, 1902 and 1903.

IMPORTS.

Raw Sugars.	Quantities. 1902. Cwts.	Quantities. 1903. Cwts.	Values. 1902. £	Values. 1903. £
Germany	6,605,719	5,788,659	2,331,336	2,454,275
Holland	337,272	198,466	110,317	76,646
Belgium	667,464	684,468	242,257	283,066
France	1,706,418	540,207	658,378	236,131
Austria-Hungary	340,523	1,685,499	126,279	709,678
Java	....	556,209	....	269,271
Philippine Islands	49,936	70,646	14,880	25,285
Peru	160,892	393,639	57,056	156,824
Brazil	578,030	78,582	191,376	31,274
Argentine Republic	808,951	418,386	305,079	184,711
Mauritius	323,736	305,164	111,398	109,396
British East Indies	202,512	286,494	73,952	106,409
Br. W. Indies, Guiana, &c.	1,280,167	672,419	754,734	404,014
Other Countries	159,872	977,875	62,365	449,862
Total Raw Sugars	13,221,492	12,656,713	5,039,407	5,496,842
Refined Sugars.				
Germany	13,465,539	14,385,796	6,997,635	7,597,927
Holland	2,387,063	2,206,666	1,370,762	1,300,685
Belgium	149,286	142,396	86,580	83,519
France	2,269,446	911,884	1,195,259	518,790
Other Countries	94,083	926,862	42,663	461,094
Total Refined Sugars	18,365,417	18,573,604	9,692,899	9,962,015
Molasses	1,381,602	1,630,112	270,174	302,039
Total Imports	32,968,511	32,860,429	15,002,480	15,760,896

EXPORTS.

British Refined Sugars.	Cwts.	Cwts.	£	£
Sweden and Norway	45,141	33,032	24,290	16,826
Denmark	137,646	99,389	69,263	54,145
Holland	72,188	70,222	37,779	37,421
Belgium	10,190	11,456	5,072	5,881
Portugal, Azores, &c.	10,935	10,257	5,326	5,857
Italy	24,116	8,462	11,328	3,946
Other Countries	415,795	796,418	246,400	490,994
	716,011	1,029,236	399,458	615,070
Foreign & Colonial Sugars.				
Refined and Candy	44,237	43,361	28,678	27,262
Unrefined	91,337	59,107	45,073	31,434
Molasses	1,955	2,642	733	1,210
Total Exports	853,540	1,134,346	473,942	674,976

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1904. Tons.		1903. Tons.
Total Receipts, 1st Jan. to Jan. 14th ..	63,217	..	33,824
Receipts of Refined ,, ,, ,, ..	—	..	50
Deliveries ,, ,, ,, ..	59,462	..	33,824
Consumption (4 Ports, Exports deducted) since 1st January	37,850	..	53,930
Importers' Stocks (4 Ports) Jan. 13th ..	15,916	..	4,385
Total Stocks, Jan. 20th	83,000	..	112,860
Stocks in Cuba ,, ...	90,000	..	88,686
	1903.		1902.
Total Consumption for twelve months ..	2,549,643	..	2,566,108

CUBA.

STATEMENT OF EXPORTS AND STOCKS OF SUGAR, 1902 AND 1903.

(Tons of 2,240lbs.)	1902. Tons.		1903. Tons.
Exports	761,077	..	879,200
Stocks	68,727	..	122,638
	829,804	..	1,001,838
Local Consumption (twelve months)	40,250	..	39,570
	870,054		1,041,408
Stock on 1st January (old crop)	19,873	..	42,530
Total production for season	850,181	..	998,878

J. GUMA.—F. MEJER.

Havana, 30th November, 1903.

UNITED KINGDOM.

STATEMENT OF IMPORTS, EXPORTS, AND CONSUMPTION FOR TWELVE MONTHS ENDING DECEMBER 31ST.

SUGAR.	Imports. 1903. Tons.		Imports. 1902. Tons.		Imports. 1901. Tons.	Exports (Foreign). 1903. Tons.		Exports (Foreign). 1902. Tons.		Exports (Foreign). 1901. Tons.
Refined	928,680	..	918,271	..	1,062,842	2,168	..	2,212	..	3,521
Raw	632,836	..	661,074	..	669,357	2,955	..	4,567	..	6,145
Molasses	81,506	..	69,080	..	85,484	132	..	98	..	2,508
Total	1,643,022	..	1,648,425	..	1,817,683	5,255	..	6,877	..	12,174

HOME CONSUMPTION.

	1903. Tons.		1902. Tons.		1901 Tons.
Refined	880,084	....	908,230	....	—
Raw	419,300	....	627,589	....	—
Molasses	79,196	....	67,165	....	—
Total	1,378,580	....	1,602,984	....	—
Less Exports of British Refined	51,462	....	35,800	....	—
Net Home Consumption of Sugar	1,327,118	....	1,567,184	....	1,730,858*

* Trade estimate.

Stocks of Sugar in Europe at uneven dates, Jan. 1st to 20th, compared with previous Years.

In thousands of tons, to the nearest thousand.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	Total 1904.
100	1515	902	670	330	3519

	1903.	1902.	1901.	1900.
Totals	3334 ..	3498 ..	2826 ..	2608

Twelve Months' Consumption of Sugar in Europe for Three Years, ending December 31st, in thousands of tons.

(From Licht's Monthly Circular.)

Great Britain.	Germany	France.	Austria.	Holland, Belgium, &c.	Total 1903.	Total 1902.	Total. 1901.
1698	871	586	424	526	4104	3980	4112

Estimated Crop of Beetroot Sugar on the Continent of Europe for the current Campaign, compared with the actual crop of the three previous Campaigns.

(From Licht's Monthly Circular.)

	1903-1904.	1902-1903.	1901-1902.	1900-1901.
	Tons.	Tons.	Tons.	Tons.
Germany	1,960,000 ..	1,767,461 ..	2,304,924 ..	1,984,186
Austria	1,210,000 ..	1,057,692 ..	1,302,038 ..	1,094,043
France	800,000 ..	833,210 ..	1,183,420 ..	1,170,332
Russia	1,200,000 ..	1,256,311 ..	1,098,983 ..	918,838
Belgium	225,000 ..	227,000 ..	334,960 ..	393,119
Holland	125,900 ..	102,411 ..	203,172 ..	178,081
Other Countries.	410,000 ..	325,162 ..	393,236 ..	367,919
	5,930,000	5,564,247	6,820,733	6,046,518

THE

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☞ All communications to be addressed to The Editor, Office of *The Sugar Cane*, Altrincham, near Manchester.

All Advertisements to be sent *direct*.

Cheques and Postal Orders to be made payable to Norman Rodger, Altrincham.

☞ The Editor is not responsible for statements or opinions contained in articles which are signed, or the source of which is named.

NOTES AND COMMENTS.

In response to a request made by some of our readers, we have decided to recommence publishing a "Contents" list every month. This will be found on Page VII.

Messrs. Blyth Bros. & Co., Mauritius, report shipments of sugar from August 1st to January 12th, at 84,685 tons, as compared with 69,419 tons for the corresponding period of the previous season. It went chiefly to India and the Cape.

The Price of Sugar.

As we anticipated, the condition of affairs in the world's sugar market has not yet been materially affected by the abolition of bounties last September. The large accumulation of bountied stocks has to be worked off at the old artificial prices; and meanwhile there is no immediate improvement in the position of our Colonial Sugar Industry, which still suffers from abnormally low prices. But these latter are destined to come to an end before long, and will give place to figures in the neighbourhood of 9s. per cwt., as under the new conditions, the continental beet sugar manufacturers can no longer afford to dump sugar into the United Kingdom at 6s. a cwt., as they did for a short while in 1902. The usual crop of mis-statements about the effect of the Brussels Convention on the price of sugar,

that periodically go the round of the newspapers, has been in evidence just lately. The chief supporters of the abolition of bounties are accused of exceeding the bounds of truth, by stating that the price of sugar would not thereby be raised. Why, say their accusers, see how prices *have* risen the last eight months. But they conveniently avoid stating from what position the rise has taken place. It has never, we are confident, been stated, either in the House of Commons, or elsewhere, by any person in authority, that the net price of sugar existing during the summer of 1902 (when it reached a minimum of 5s. 10½d.) would remain the normal price when bounties were abolished. On the contrary, it was affirmed that that price could not continue long whether bounties were abolished or retained. The real question at issue was the *average* price, and in that connection, the President of the Board of Trade asserted that the average price in future years would not exceed 10s. per cwt., whereas during the last ten years it had been 10s 6d. But the opponents of this new sugar legislation, in order to make out a blacker case, amalgamate two entirely independent influences which tend to raise prices, and the sum total is laid to the door of the Brussels Sugar Convention. They blame the latter for the fact that to the price of sugar f.o.b. has to be added 4s. 2d., the tax imposed in this country on refined sugar. If sugar is 8s. f.o.b. Hamburg, it may be roughly 12s. landed here; it is a convenient plan, therefore, to refer to the sugar as at 12s., and to compare it with the 6s. of two years ago. These are grossly unfair tactics, but are only too likely to deceive "the man in the street" with his limited knowledge. Whether the Government be right or wrong in deeming sugar a suitable article to tax for revenue purposes is a matter of opinion, but the imposition of this tax lies utterly apart from the question of the effect on the price of sugar occasioned by the retention, or the abolition, of bounties. This last should be judged on its own merits, and there has certainly not yet been enough time allowed to ensure a fair trial.

Beet Sugar Growing in the United Kingdom.

Elsewhere will be found reproduced an interesting paper dealing with the progress and prospects of sugar beet culture and manufacture in the United Kingdom. Mr. Sennett deals enthusiastically with his subject, and the details he gives seem to leave no doubt that sugar beets can be successfully grown in this country and will compare very favourably with the continental productions. The picture drawn of the immense amount of capital and labour that could be utilised to form a home sugar industry seems very alluring; but it is permissible to ask what in that case will become of the British Colonial cane sugar industry when the home market we have been endeavouring for some years past to provide them with, to ensure their permanent prosperity,

is taken from them once more by a possibly subsidised home beet sugar industry. There is another alternative which would ensure the success of part at least of Mr. Sennett's plan, and yet leave the sugar trade to be supplied by those of our colonies with whom sugar will always have to remain the staple industry. By all means grow the beets but manufacture therefrom, not sugar, but alcohol spirit for use as the motive power of motor vehicles. These latter are at present practically dependent for their supply on American mineral oils from which the petrol (or gasoline) is distilled, and the monopoly existing is not to our advantage, as we may be called upon to pay any sum the American distillers see fit to charge. Alcohol, whether made from beets or potatoes, has been tried with success in France as a motor spirit, and we see no reason, apart from the excise duty on such spirit, why its adoption in this country should not be hastened by the establishment of a supply of home manufacture. The motor industry is such a growing one, and capable of such infinite expansion, that it would be a pity for it to be throttled for want of a cheap and plentiful supply of the requisite spirit.

But if this country *is* to turn out its own sugar the prospects seem good. Mr. Sennett advocates the adoption of the advantages permitted by the *Surtax*, which ensure to any particular party to the Brussels Convention a bounty of £2 10s. per ton on its home-grown sugar. As all the States participating in this Convention who are sugar manufacturers, have availed themselves to the fullest extent of this allowance, there seems no reason why Great Britain should not do likewise and stimulate a new industry which otherwise might have an indifferent existence. There are however the Cobden Club and the "Free Fooders" to be seriously reckoned with, and they would be aghast at the suggestion that (as they would put it) a particular industry should benefit at the expense of the consumers. And at any rate when Mr. Sennett suggests that the consumer would benefit directly by this subsidy of 2s. 6d. per cwt. as the manufacturers would be able to turn out sugar proportionately cheaper, we think he is over-sanguine. It is to be feared that the manufacturers would be tempted to follow the policy of their continental confrères and only give away as much of their advantage as would secure the market for themselves. This would certainly ensure a lower price than otherwise, but hardly to the extent Mr. Sennett suggests. Home competition might further reduce prices, but on the other hand a home combination might just as conceivably do the opposite. We think the benefit to the consumers would be what after all is the most desirable condition, viz., a steady market price and a plentiful supply. These points guaranteed, there is no real objection to helping to establish a new industry on a large and prosperous basis by means of the advantages allowed under the *surtax*.

Non-Technical Papers on Sugar.

It will be remembered that this Journal, under its earlier name, *The Sugar Cane*, was devoted exclusively to giving information on the cane sugar industry in all its stages. But in 1899 it was decided to enlarge the scope of the paper and include matter relating to the beet sugar industry within its pages. At the same time, preference was to be given as much as possible to the original subject. Unfortunately, owing to the effect of the bounties in stimulating the growth of the beet sugar industry, its older rival has of late years fallen into bad times, and, as a consequence, there has been little new experimental work to chronicle, especially in the British Empire. This has resulted in our having less to offer to the planter and more to the technicists of the refinery during the last year or two. It is our desire to remedy this as much as lies in our power; and in order to cater for the class of readers to whom the average technical paper is too abstruse, we have arranged to publish a series of non-technical articles from the pen of Mr. T. H. P. Heriot, who has had a practical experience of the cane industry. These papers are not intended for the expert or professional man, but should appeal to the more numerous class of planters and their assistants.

THE SUGAR TRUST IN SPAIN.

The Board of Trade has received, through the Foreign Office, copy of a report drawn up by the Spanish Commercial Attaché at Madrid on a company which has recently been formed in Spain, amalgamating almost all the sugar factories of that country. This company, which is known as the "Sociedad Azucarera Española," has a share capital of 100,000,000 pesetas and a loan capital of 60,000,000 pesetas. One of the largest sugar firms, that of Larios, has, however, remained outside the amalgamation, but an agreement has been arrived at between this firm and the sugar company, whereby the relative output of each is fixed, and certain other arrangements are made to avoid competition.

According to the report referred to, there are now 79 sugar factories in Spain, 31 of which work up cane and 48 beetroots. The production of sugar in Spain during the past two years has been greatly in excess of the demand. In 1901 the output amounted to 118,389 metric tons, and in 1902 to 114,968 metric tons; whilst the sales were only 87,895 metric tons and 84,238 metric tons respectively. This excess of supply and demand naturally led to a fall in prices and a general depression of the industry. The trust calculates the future annual output at 90,000 tons; 9,500 of which are to be allocated to the

factories belonging to the firm of Larios, whilst 81,500 tons are to be produced in the factories of the trust. A statement issued by the trust shows an estimated gross annual profit of 28,000,000 pesetas, taking the price obtainable for the sugar produced at 1,150 pesetas per metric ton. In 1902, under the pressure of over-production, the price obtained by the sugar factories had fallen to 800 pesetas per metric ton; when it is borne in mind that beets cost 400 pesetas per metric ton, and the internal sugar tax amounts to 250 pesetas, whilst the cost of production is estimated at 180 pesetas, it will be seen that sugar production could hardly be carried on profitably; in fact many sugar companies showed heavy losses on their working.

The Commercial Attaché gives an interesting sketch of the history of the Spanish sugar industry, from its rapid and brilliant development in 1899 to its present depressed condition. Owing to the war and other connected causes, the Spanish imports of sugar from Cuba fell from 46,929 metric tons in 1895 to 28,065 metric tons in 1897, and 9,301 metric tons in 1899, and at the same time the Spanish sugar industry grew rapidly under the protection of heavy import duties imposed in 1898 and 1899, the import duty on foreign sugars being fixed at 85 pesetas per 100 kilogs., whilst the internal tax on sugar produced in Spain was 25 pesetas only per 100 kilogs. This high rate of duty enabled the then existing factories to make huge profits, amounting in some cases in two years to 100%; these large profits attracted capital to the industry, and the number of Spanish sugar factories rapidly increased. In 1899, 26 factories were in existence, 21 of which were fully working; in 1901, the number of factories had increased to 48, and in 1903 to 79,. the over-production, for which it is hoped the amalgamation referred to will prove a remedy, being a natural result.

In connection with the description of the new Central Sugar Factory for Antigua, which was given in our last issue, we are informed that the two water-tube boilers referred to, as being part of the plant to be sent out, are to be manufactured by Messrs. Babcock & Wilcox, Limited.

The Austrian Lloyd Steamship Co. have arranged to reduce the freight on Austrian sugar to India, China, Japan, &c., on condition that all the sugar shall be shipped exclusively by their own steamers. The reduction in the freights to India is from 17s. to 14s. per ton; but they have been at the latter figure before, and it is doubtful whether any material increase in the imports of Austrian sugar into India will follow.

SCIENCE IN SUGAR PRODUCTION.

By T. H. P. Heriot, F.C.S.

Introductory.

It is almost a truism to state that rivalry induces progress; the individual is for ever sharpening his wits or developing his muscles in order to outdo his neighbour. National rivalry in times of peace may be less obvious, but is none the less certain, and is ever tending towards future industrial monopoly. The recent critical condition of the West Indies affords a striking example of a once prosperous British industry being outdistanced by a modern competitor.

With the abolition of continental bounties, it is to be hoped that the cane industry will enter upon a new and prosperous career. From a review of the past, some useful lessons may be gathered for future practice, and with this end in view, we propose to study the progress made in the rival industries from a scientific point of view, to enquire what has been accomplished by scientific knowledge and engineering skill; and to what extent the cane industry has benefited by the experience of its progressive rival.

To compare British with foreign progress, it will be instructive to confine our study of the cane industry to that of our West Indian colonies, as being fairly typical of modern methods, and most seriously affected by competition with the beet.

To facilitate comparison, both industries will be reviewed under the several heads of the following syllabus; priority in order being given to the older cane industry, except where it has followed the progress of the beet.

Avoiding statistics and fiscal questions, we intend to visit the field and the factory: commencing with the raw materials, to enquire into the origin of the cane and beet, noting what has been done to improve these raw materials; to consider certain agricultural problems in the field, and compare the cane-crop with that of the beet. Arriving at the factory, a brief description of the earliest attempts to extract sugar from the cane and beet will deserve notice before examining modern methods and machinery. The study of manufacturing operations will include:—

1. Extraction of the juice.
2. Purification of the juice.
3. Concentration of the juice to syrup.
4. Crystallisation of the syrup.
5. Separation of the crystals in the form of dry sugar.

We shall next enquire how much sugar, present in the raw materials, can be recovered in the form of saleable crytals, and how far it may be possible to reduce losses in manufacture. This will lead

to the value of the by-products and how they are utilized. Finally, conclusions will be drawn and some attempt made to indicate in what directions the future progress of the cane industry may be looked for.

It will be well, at the outset, to clear up any misconception as to the title of these papers by quoting Herbert Spencer's definition of science as "a higher development of common knowledge."

The scientist is not a magician, but a trained experimenter and observer. His special knowledge is the condensed results of the experience of past and present ages, which have been collected, classified, and labelled under the various sciences of agriculture, biology, botany, &c.

Why, then, does the practical man so often regard science as "theory" in supposed opposition to his hard earned experience? We answer, because he mistakes the tools of science for its results. Theory is but a step towards practice. In attacking a new problem, whether in the field, the factory, or the laboratory, the scientist proceeds upon definite lines. He compares the new facts or conditions with others of similar nature which have been more closely studied. He then forms one or more theories to account for the new facts, and proceeds to test them by suitable experiments. If the theory is confirmed by experiment, well and good; if not, the theory is promptly abandoned, a new theory substituted, and further experiments made.

If we have succeeded in showing the essentially practical nature of scientific method and research, the subject before us needs no further commendation to the readers of this journal.

I.—The Raw Material.

Sugar is manufactured by the plant, the green leaf is Nature's factory, and the raw materials are to be found in sunshine, air and water. The chemist discovers that sugar is composed of the three elements: oxygen, hydrogen and carbon. The two former are gases, which, in chemical combination, form water. Carbon is solid; it is found in a pure state in the diamond; black lead, soot and charcoal being cruder forms of the same element. When substances containing carbon are burned the carbon combines with oxygen of the air to form an invisible gas, carbon di-oxide, which is also exhaled from the lungs of man and animals. This gas is consequently always present in the atmosphere in small, but fairly constant, proportions.

In the minute structure of the leaf, and under the influence of sunlight, carbon di-oxide is decomposed by the plant, the carbon being abstracted and united with the elements of water to form complex chemical compounds such as sugar, woody-fibre, starch, &c.

The bulk of every living plant consists of water, in which are dissolved sugar, gums, salts, acids, &c., causing the sap to be sweet, gummy, saline or bitter.

Plants require but a small quantity of mineral food, which they derive entirely from the soil, and which remain as "ash" when the plant is burned.

We may therefore state that the living structure of the plant, and the substance dissolved in its sap, are almost wholly derived from the atmosphere.

Sugar forms the food of the growing plant, for the nourishment of leaves, stem, and roots, and accumulates in the sap as a reserve supply for future offspring.

Sugar was obtained from the cane some thousand years before it was discovered in the sap of the beet; hence the name "cane sugar" has been retained as indicating the original source, but is equally applicable to this substance when extracted from other plants. The name "beet sugar" should, therefore, only indicate the origin of extraction, there being no difference between cane and beet sugars when freed from impurities, and crystallized under similar conditions. The popular belief in the superior sweetening power of cane sugar has been partially accounted for by Prof. Juntz, whose experiments proved that if a mere trace of quinine or of salt be added to a solution of pure sugar, the mixture appears sweeter than the pure solution to nine-tenths of those who taste it. He attributes this fact to the simultaneous excitation of adjacent groups of nerves on the palate, one group being sensitive to sweet, another to bitter, and yet another to saline substances. In his experiments the first group of nerves was strongly excited, and the second or third very feebly, with the result that the saline or bitter tastes were not detected as such, but merely added to the prevailing sensation of sweetness. He adds:—

"I would suggest for consideration the question whether the assertion of many individuals that colonial sugar is sweeter and more agreeable to the taste, is not based upon the fact of its containing admixtures of palatable and odoriferous substances."

In the sugar-beet and cane we, therefore, find two very different plants cultivated for the extraction of one and the same substance. Both have been greatly modified by long cultivation, and, as the starting point of our enquiry, we shall regard, as the raw materials of the sugar industries, the cane and beet when first cultivated for their saccharine value.

The Cane.

Some wild type of the sugar cane was doubtless chewed by prehistoric man during his rambles in search of food. The following historical notes are extracted from Porter's work:—

"The strongest proofs lead to the conclusion that China was the first country in which the sugar cane was cultivated and its produce manufactured, about two thousand years before it was known and adopted in Europe.

"Sugar appears to have been one of the latest known of the Eastern

products. No mention is made of it in the history of ancient Egypt, Phœnicia, or Judea. The Greek physicians are the first who have spoken of it under the name of 'Indian salt,' which was brought to Greece and Rome from India. The cane then only grew in the islands of the Indian Archipelago, in Bengal, Siam, &c.

"The Indians, who carried sugar to Ormus and Musiris, informed the merchants, who bought their commodities, that they extracted it from a reed. This indefinite assertion, stripped from all circumstantial details, gave rise to a variety of opinions concerning a plant which yielded so extraordinary a product. Some thought it was a kind of honey, formed without the assistance of bees; others, that it was a shower from Heaven which fell upon the leaves of the reed; whilst others again imagined it was the concretion of the reed formed in the manner of gum. These fanciful speculations were put an end to in the year 1250 by Marco Paulo, a Venetian, who visited the country where the canes actually grew. His example was followed by the merchants, who brought away the cane and introduced its culture into Arabia, Egypt, and other parts of Africa, where sugar was made in abundance towards the close of the fourteenth century.

"Much before this period, however, the cane had been brought into Europe, being cultivated in Sicily and Spain. It was taken to the Canaries and to Madeira in 1425, by Don Henry of Portugal; the sugar from Madeira being greatly preferred to that of any other country.

"The Portuguese began the cultivation of cane in the island of St. Thomas, immediately after its discovery.

"Soon after Columbus discovered the New World, one Pierre d'Etienne planted the cane in Hispaniola, now Hayti, where it is said to have flourished, and the cultivation to have extended with such rapidity that the cost of the magnificient palaces of Madrid and Toledo, built during the reign of Charles the Fifth, was defrayed by the proceeds of the port duties on the sugar imported from the island.

"In 1466 the use of sugar in England was confined to medicines and feasts, and this continued until 1580, when it was brought from Brazil to Portugal and thence to our country.

"In 1641 sugar canes were transplanted from Brazil to Barbados, and thence to our other West Indian islands. The French also introduced plants from the East to the West Indies, whence they found their way to some of our colonies, amongst these being the Bourbon, Batavian, and Otaheite canes. These appear to have been so much superior to the old Brazilian plants that the latter were nearly banished from our islands."

The sugar cane is a perennial, belonging to the family of grasses. From time immemorial it has been propagated from cuttings, but within comparatively recent years it has also been reproduced from seed. A description of the plant in this journal would be superfluous.

The cane contains three distinct kinds of sap which are not equally

distributed throughout the stem, causing the younger and greener parts to contain much less saccharine juice than the lower and riper portions. This juice is enclosed in microscopic cells of delicate structure, whereas the other saps, containing little or no sugar, are contained in the harder and fibrous portions of the stem; whence it follows that a purer and sweeter juice can be extracted by old fashioned mills than with the powerful machinery of to-day.

The Beet.

This also traces its descent from some wild ancestor, the food value of which must have been early recognised. The discovery of sugar in this root by the chemist Margraff in 1747, and the successful attempts to extract the sugar by Achard in 1796, was the dawn of the modern "sugar-beet." From that time to the present day the root has been cultivated with a new object and its saccharine value wonderfully increased.

History records the consternation of the cane planters when they heard of Achard's discoveries, and that they offered him £30,000 if he would publicly deny the truth of his assertions that sugar could be made from the beet, but the bribe was of no avail. The industry was born in Germany and rapidly extended to France, Austria, and other countries.

Napoleon I., backed by the scientific knowledge of one of his ministers, Chaptal, made great efforts to encourage the new industry. The first loaf of refined sugar was obtained from the beet by the French chemist Derosne, and presented to Napoleon, who preserved it under a glass case in his study. Shortly after the fall of Napoleon the industry nearly collapsed, but revived on sounder scientific principles.

The raw material was a white beet of Silesia, which was found to contain from 3 to 6% of crystallisable sugar. This plant is one of the many varieties of the *Beta vulgaris*, which includes the red or garden beet, the white and yellow beets, the mangel-wurzel, and others.

The sugar beet is a bi-annual, and is propagated from seed. During the first year's growth the plant develops leaves and root, the latter attaining its full size and saccharine richness.

The root is harvested in the late autumn, the period of growth being about 150 days. For the production of seed a certain number of roots are replanted in the following spring, when a new phase of vegetation commences. The sugar, accumulated by the root during the first year, now serves to nourish a stem rising from the centre of the neck, which blossoms and finally runs to seed. In the following autumn this is carefully collected, after which the mother plant withers and dies.

The sugar beet thrives in a variety of climates, and has been most successfully cultivated in the British Isles.

(To be continued.)

LIST OF PROCESSES SUBMITTED DURING THE LAST TEN YEARS FOR THE PURIFICATION OF SUGAR JUICES.

In 1897 I referred to an article of Von Lippmann's, which appeared in the *Deutsche Zuckerindustrie*, wherein he gave a list of the various chemicals which had at various times been suggested for the purification of sugar syrups.

The list contained 287 substances, which were subdivided as follows :—

Acids of sulphur and allied products	.. .. ..	40
,, phosphorus	,, ...	25
Different inorganic acids	,, ...	23
Oxygen, halogens	,, ...	17
Alkalis, alkaline earths	,, ...	48
Metals	,, ...	66
Organic substances	,, ...	56
Electrolytic substances	,, ...	12
		287

I remarked at the time that as none of the above articles, with the exception of lime, sulphurous acid, phosphoric acids and its salts, and carbonic acid, have been utilised to any extent, the chance was very slight that any one of the above-mentioned clarifying agents should possess all the advantages which the inventors claimed for it.

Since the publication of Lippmann's article, a fresh crop of inventions has sprung up, as will be seen by the following extracts from the *Archief*:—

I. Chemical Processes.

1. *Ozone. Verley Process.*—Ozonized air (2–3 mgr. of ozone per litre) is forced for 2-4 hours through the thick syrup about 20 Beaumé which has been cooled to 25-30° C. When cold, the syrup is mixed with compressed sulphurous acid, so that an acidity of 0·02% is reach. Thereupon baric-hydrate (baryta) is added until the liquid is faintly alkaline; it is then boiled, filtered, and evaporated to massecuite. (Unfavourably reported upon by Herzog.)

2. *Peroxide of Hydrogen. Herriger Method.*—Peroxide of hydrogen in 3% solution is added to syrup with milk of lime, under the simultaneous influence of carbonic acid. On the first saturation (alkalinity 0·12) 5% of the solution is added; on the second (alkalinity 0·08) 2½%, and on the third saturation with sulphurous acid, once more 2½%, or a dilution of 10% only through the solution of peroxide of hydrogen. The *colour* of the syrup, which before treatment was 2·86, becomes afterwards 1·25. (Tintometer numbers.)

3. *Chlorine with acetylene. Isidor Kitsée Patent.*—The syrups are treated with chlorine in a specially constructed reservoir, whereby the

colour is bleached. In order to abstract the chlorine, acetylene is conducted through the syrup, forming an insoluble substance, which floats as an oily layer on the surface, and may be removed by skimming.

4. *Ammonia. Kovalevka Method.*—Beet syrup is made feebly alkaline with ammonia before carbonatation, whereby a strong crystalline deposit is formed. After six hours the purity had improved 0·5 %, and after 32 hours it had increased still further. The deposit, which amounted to 1·19-1·62 gr. per lit., consisted to the extent of 86 % of ammonia-magnesic phosphate.

5. *Barytes. Beaufret Method.*—1 kil. of barytes to 1,000 kil. of beets is dissolved in the diffusion syrup, which is heated to 75°. Lime is added (1·4 %), and carbonatation continued until alkalinity equals 0·9 CaO per lit. at 90° C. Before the second carbonatation, 0·5 % lime is used, and saturation is proceeded with to 0·10 % CaO. As basis for the quantity of barytes to be used, the organic non-sugar in the first masse-cuite is taken. If the same amounts to 4·5 %, then 1 per mil of barytes is used.

Manoury Method.—Cane juice is first defecated with lime, to neutralise the acid. Afterwards the juice is heated and a scum forms, which is skimmed off. To the clear syrup, 1 kil. of barytes is added to 1,000 kil. of cane: the syrup is boiled, then again skimmed. Afterwards the alkalinity of the syrup is ascertained, and magnesium sulphate is added in sufficient quantity to reduce the alkalinity to 0·01 %. The syrup is boiled, allowed to settle and filtered.

6. *Barium peroxide. Ranson Process* (1).—Cane or beet juice is mixed with 2-5 % of a milk of barium peroxide of 10-25 Beaumé and allowed to stand an hour or more, so that the formation of gas ceases. The liquid is sprayed under pressure into a vessel with carbonic acid, whereby barium carbonate and sugar solution are produced, which are separated by filtration.

7. *Caustic soda. Winter's Method.*—One-half to one litre of caustic soda solution of 40° Beaume is added to 1,000 lit. molasses syrup, and about the same quantity of lime.

8. *Sulphurous acid. Winter's Method.*—This is added in the unclarified syrup, in defecation, in the third saturation, to thick syrup, molasses, &c., to decolorise, purify, sterilise and to diminish the viscosity of the by-products.

9. *Sulphurous acid and zinc. Ranson Process* (2).—Thick syrup of 20-25° Beaume in an alkalinity of 0·80 gr. CaO per lit. is fumigated with sulphur until neutral to phenolphtaleine, and filtered. The mixture is cooled, fumigated with 1 gr. SO_2 per lit., and 1 kil. zinc dust is mixed with 45 hectol. thick syrup; after 20 or 30 minutes the mixture is heated to 75° C and filtered again.

10. *Sulphurous acid and tin. Ranson Process* (3).—In place of zinc, pulverised tin is employed, which yields insoluble combinations.

11. *Sulphurous acid and ferrocyanide of potassium. Boot System.*—The liquid to be decolorised is warmed to 75-95° C, and sulphurous acid added. Then ferrocyanide of potassium or any other combination of ferrocyanide is added, about 2-10 gr. per lit., which reduces the traces of iron which are found in the liquid, as well as useless or detrimental substances, such as albumen, &c.

12. *Calcium chloride. Eydman Process.*—Calcium chloride solution is added to syrup treated with lime, in order that the precipitated impurities may sink more readily to the bottom.

13. *Barium chloride. Prinsen Geerlig's Method.*—To 1500 lit. syrup 12 lit. of a 5% solution of barium chloride and the usual quantity of lime are added; the mixture is boiled, allowed to settle, and filtered. As the syrup retains some barytes after filtration, the writer objects to this method.

14. *Magnesium sulphite with sulphuric acid. Saillard's Patent.*—To molasses which has been diluted to 30° Beaumé, 3% of acid magnesium sulphite is added, and after it has stood for two hours, sufficient slaked lime, mixed with water, to cause the solution to remain slightly acid. It is warmed to 100° C. and decanted. The clear syrup may be mixed with the defecated syrup or conveyed to the boiling pans.

15. *Permanganate of lime. Fayolle's Patent.*—The unclarified syrup is treated as usual with lime, then saturated twice with carbonic acid, with this difference however, that the syrup which remains muddy after saturation and still contains a certain quantity of lime, is filtered, and treated with a solution of permanganate of lime of 25-30%. This must be added whilst the liquid is cold or lukewarm. The permanganate is allowed to work for 25 or 30 minutes, and saturation is proceeded with as usual: towards the end the mixture is warmed in order to remove the bicarbonates which have been formed. The solution is neutralised with acid, so that the syrup retains a feeble alkalinity. If sulphurous acid is employed, then the solution shows a distinct acid reaction, which is just sufficient to prevent the massecuite from becoming darker.

16. *Zinc hydrocarbonate. Perrin's Patent.*—Zinc hydrocarbonate is obtained by mixing a solution of zinc sulphate with a solution of carbonate of soda, whereby a deposit of zinc hydrocarbonate is formed. (1.) This is mixed with the syrups, which are stirred and filtered. The zinc salt causes a precipitate, which contains the organic and colouring matters, and which remains upon the filter, whilst the juice runs off pure and clear. The process may also be worked in the following manner:—(2.) The mixed liquids, from which the zinc hydrocarbonate is precipitated, is allowed to run into a filtering press. As soon as the chambers are filled with the zinc hydrocarbonate, the inlet is closed, and warm wash-water is passed through the press until the effluent water contains no more sulphuric acid or carbonate of soda. Then the filtering of the syrup can be commenced; and as soon as it

is noticed that the liquid no longer runs clear, the inlet is again closed, and the press washed free from syrup. The zinc hydrocarbonate is next washed with a warm solution of carbonate of soda, and afterwards with warm water, after which the filtering press is again ready for use.

17. *Tin fluoride. Ranson Process* (4).—A solution of tin fluoride of 20-25 Beaumé is added to the syrup to be purified. Ordinary stirring is sufficient to mix the solution quickly with the syrup. The tin fluoride only has the effect of decolorising and purifying the syrup. If the syrup has been treated beforehand with sulphurous acid, then hydrosulphurous acid is formed, which is well known for its decolorising and purifying action. Finally, lime is added to the syrup, to eliminate any possible excess of the reagent.

18. *Aluminium. Besson Process.*—A small quantity of aluminium powder or an alloy of alumium and tin is added to the syrup before it is put into the evaporators. The thick syrup is thereby strongly decolorised and slightly purified, enabling evaporation to take place more rapidly. The escape of gases, due to the action of the metals on the syrup, facilitates the boiling, and prevent overheating and incrustation of the heating tubes.

19. *Ferruginous quartz-clay. Harm System.*—Ferruginous quartz-clay separates from the syrup the principal molasses-producing impurities and has at the same time a purifying and decolorising effect. The alkalis, and the organic bodies are carried down in the deposited clay. This process may be applied to the unclarified as well as to the clarified syrups, if the latter contain no free lime. The purification of the syrups is obtained by the mixing of the same with the afore-named pulverised silicate, with separation of the resulting deposit.

II. Electrolytical Methods.

20. *Electrolytical purification of syrups. Schollmeyer and Huber Process.*—Syrup, previously freed from mechanical impurities, is warmed to 80°, mixed with lime, so that it contains 2·5 gr. per L., and then passed through four compartments, in each of which there are five electrodes. Of every five electrodes, three are connected with the positive pole and two with the negative, or *vice versa* as the current is changed. After electrolysis, carbonatation follows, which requires 26-30 % less lime than would otherwise be the case. No greater yield is obtained; the advantage consists in economy of lime and quicker work.

21. *Electrolytical purification of syrups. Madejski Method.*—Syrup is mixed with $\frac{1}{4}$ % of lime and submitted to electrolysis. After the action of the current, the syrup is filtered, leaving a deposit containing much organic matter in the filter. By this method an equal purification is obtained as by the use of 3 % of lime and threefold saturation.

22. *Electrolytical purification of syrups. Say-Gramme Method.*—Cane sugar syrups are purified by electrolysis using leaden electrodes:

(1.) By adding a fixed quantity of soluble salt or of a strong acid, which, combining with the lead, forms insoluble or hardly soluble compounds; it is added to the syrup in such a way that through its continuous action on the lead during the process, the anode remains perfectly clean, whereby a complete purification of the syrups is brought about. (2.) With anodes in the form of a sinusoid, which are subjected to opposite motions, corresponding with the direction of the current, in order to bring about the thorough and repeated contact of the lead with the sugar solution wherein the anode is submerged.

23. *Electro-manganese Process.*—The syrups are mixed with powdered calcium manganate and thereupon exposed to the action of an electrical current. The calcium manganate serves as a transmitter of the oxygen, which electrolysis liberates from the water, combining with same to form permanganate, but yielding up this oxygen to the organic substances which oxydise more easily than sugar, being thereby again reduced to manganate.

24. *Electrolytical purification of syrups.*—The salts in the syrup are electrolysed by the electric current, and the liberated acids and bases are dialysed through diaphragms, so that the sugar alone remains in the juice.

25. *Electrolytical purification of syrups. Kollrep & Wohl's Method.*—The alkalis are separated electrolytically, and the liberated acids are mixed with basic lead or zinc substances in suspension in the syrup, or with saccharate of lead. For this purpose indifferent electrodes may be used, *i.e.*, which are unaffected by deposit, and which do not require renewing.

III. Mechanical Methods.

26. *Separation of albumen.*—The syrup is warmed to 60°, whereby the albumen coagulates, and is filtered through a special filtering cloth.

27. *Separation of albumen through centrifugalling. Hignette System.*—This process consists in the treatment of syrups, either cold or warm, with a small quantity of lime, and the separation of the deposit in centrifugals of special construction, whereby the clear syrup and the scum flow off separately in a continuous manner. Through the addition of 0·3-0·5% of lime to the syrup, and treatment with carbonic acid in the centrifugal, one obtains a syrup with a purity at least equal to, sometimes higher than, that of syrup after the addition of 20-30 gr. of lime per lit. and double carbonatation.

28. *Superheating. Deming System.*—Cane juice is heated with a little lime under pressure at temperatures over 100° in order to obtain a better coagulation of the suspended impurities.

29. *Separate defecation of the different molasses syrups.*

30. *Precipitation by means of clay. Kramer's Suggestion.*—In order to facilitate the deposit of the defecation impurities, the syrup is mixed with clay batter, which, owing to its floculent nature, makes the sediment heavier and promotes subsidation.

31. *Carbonate of lime. Dabrowski & Kaczmarkiewicz's Patent.*—The diffusion syrup is treated with natural powdered carbonate of lime, also with milk of lime. The powdered carbonate of lime is obtained from limestone, chalk, or pure marl. To the diffusion syrup one adds, with continual stirring, 1 % or more of powdered carbonate of lime, and sufficient milk of lime to impart to the syrup an alkalinity of 0·07. The syrup is afterwards heated to 80°C., whereby the sediment formed is separated more easily. The liquid is filtered through filtering presses, and the syrup further saturated once or twice in the usual manner, for which about 1 % of lime is required.

32. *Filter deposit of a previous filtration. Kuthe & Anders's Process.*—The syrup is heated to the temperature at which albumen coagulates, then mixed with 1 to $1\frac{3}{4}$ % of lime and with filter-deposit of a former working; it is advisable to use the filter deposits of the first or second saturation. Factories which use lime in the form of milk of lime, do well to stir the dry press-cakes in the milk of lime, breaking them up small.

33. *Aluminium sulphate and milk of lime. Lehmkuhl Method.*—In order to render the sediment more easily filtered, a solution of aluminium sulphate is added to the syrup, and then, to obtain defecation, half the usual quantity of lime is sufficient.

34. *Cold separation with infusorial earth. Ragot Process.*—To the unclarified syrup sufficient powdered lime or milk of lime is added, until a further addition of lime does not cause any precipitate. In order to be able to filter this limed syrup through filtering presses, infusorial earth (kieselguhr) is added, to the extent of 25-35 grams per litre. The syrup obtained by this cold process is then treated in the usual way with lime and carbonic acid, with this difference, however, that one obtains an equally good, if not better, separation with 1-$1\frac{1}{2}$ % of lime than otherwise with 2·5-3 %.

Stutzer & Werneckink Process.—Syrup is treated in specially constructed boxes with any acid or salt at a temperature of 45-75°C., with continual stirring. For this purpose one may use the chlorides of calcium, barium, or magnesium, in very small quantities, or tartaric acid and its acid salts; the best is sulphurous acid. Thereupon the liquid is mixed with 2 % of kieselguhr or infusorial earth, which has previously been washed for a considerable time. It is then heated to 80 or 85°C. and passed through a filter, with or without pressure. The filtered syrup is perfectly clear, and is more or less coloured according to the quality of the beets; it is purified with lime, but much less is required than is usually the case.

35. *Asbestos. Maignen's Filter.*—A bag of asbestos cloth with cane rings, in the form of a Chinese lantern, is immersed in a pan containing the syrup. The suspended impurities deposit on the outside of the asbestos, and the clear liquid filters through.

Van Breyer Filter.—The syrup is filtered through a specially constructed filter made of asbestos, so that without the addition of lime, the syrup, freed from any sediment or inorganic colouring matter, flows through quite clear.

36. *Cork. Danek Filters* filled with pieces of cork give a clear filtrate; the working is very clean, simple and cheap.

37. *Sand. Abrahams's Sand Filter.*—A filter of special construction is filled with sand of a certain sized grain, and serves to filter syrups. When the filter becomes fouled, it is cleaned by a stream of water.

A goodly number of inventions have thus come to light during the last few years. The inventors have explored the whole range of science, with the sole object of discovering means for the purification of sugar syrups. Most chemical and electrolytical processes have one object in common, *i.e.*, to assist precipitation, to oxydise, reduce or decolorise all non-sugars, whilst leaving the sugar untouched.

When we see, however, how few of these new methods have been adopted in practice, we are driven to the conclusion that most of them do not possess the advantages which are claimed for them. This consideration causes us to assume a somewhat sceptical attitude in regard to any new process for the purification of syrups, so that we do not immediately believe in its infallibility, for it might already have been tried and found wanting.

When we compare the foregoing list with that of Von Lippmann, we perceive the application of Solomon's utterance of ages ago, even to the sugar industry, when he came to the conclusion that "there is nothing new under the sun."—(After H. C. Prinsen Geerligs, in the Java *Archief.*)

More cane sugar for refining is reaching the United Kingdom now, and Liverpool seems to be getting the preference as the port of arrival. The heavy dock charges of London do not conduce to increasing supplies.

The Government of French Indo-China is supporting a scheme for establishing in Annam a sugar refinery capable of treating 50,000 tons of sugar a year. It is proposed to levy an excise duty of 5 fr. per 100 kilos. on the output of this factory.

RECIPROCITY OR FAIRPLAY.

An interesting discussion has recently been carried on in the columns of "*The British Trade Journal*" on the question of preferential tariffs. Self-governing colonies as well as Crown colonies have been referred to; but the references to the latter are of more immediate concern to us. A correspondent signing himself "Engineer" wrote: "Before abolishing bounties and paying more for our sugar on behalf of the British West Indies, the Colonial Office should have arranged the introduction of a preferential system with those colonies. In the absence of such a tariff system it is possible that the orders for machinery consequent on the higher prices of sugar, which come out of the pockets of the English consumers, will go to the United States." It will be noticed that this correspondent mistakes the purpose of the abolition of the sugar bounties. The effect is not to give the British colonial sugar a preference over other sugars, but to put it on the same footing. If the British Government were to desire a preference in the sugar colonies for machinery of British manufacture, it would be necessary on their part to reciprocate with a preference for colonial produce. In reply to "Engineer's" letter, Mr. Guy Wyatt, of this colony, pointed out that it was a mistake to think that as yet the West Indies had benefited by the Convention. The price of sugar had not risen and was not likely to until the excessive Continental stocks of beet sugar had been reduced. He continued "I know of few modern up-to-date refineries in the United Kingdom. In the expensive cost of transportation of raw and refined, there is, perhaps, enough to pay a dividend on money invested, in modern refineries with deep water for large steamers, canal and railway, all available at their doors, for handling cheaply raw and refined sugars. In the United States the refiners are much better situated. 'Engineer' might agitate for such modern refineries to be built (now that the bounties are abolished) at inexpensive new sea ports in the United Kingdom, and supply most of the new machinery for them." Mr. Wyatt added that American machinery had been imported into the West Indies, but apart from the fact that America has been taking the bulk of the West Indian sugar, "lighter," better, and more finished mills and other labour-saving appliances have been found to exist in the United States than in the United Kingdom." Still, if the United Kingdom became the leading market for West Indian sugar, British engineers would find that it would be to their advantage. Mr. Wyatt concluded: "The West Indies have now to work for very close reciprocal arrangements both with Canada as well as Great Britain." In reply to this the Editor of "*The British Trade Journal*" asks: "Are British engineering firms to understand from this that the colony will refuse to accord preferential terms to British machinery?" Certainly not. If the British Government were to adopt a preferential

tariff it would be found that the West Indies and this colony would readily reciprocate. But apparently the Editor falls into the same error as his correspondent "Engineer" in thinking that by the abolition of the bounties West Indian sugar gets an advantage in the home market. This, unfortunately, is not so; it only gets a measure of fair-play which has been denied it for nearly 50 years. Commenting on Mr. Wyatt's letter, the journal in question says: "The United Kingdom, in our correspondent's opinion, is not likely to obtain preferential treatment for its machinery in the West Indies, which are to buy their requirements from the United States, because the United States buys West Indian sugar. Our correspondent 'Engineer' recently called attention to an oversight on the part of the Colonial Office in not obtaining a *quid pro quo* for the abolition of the bounties; and Mr. Chamberlain will have a good deal to say to the Crown colonies if they prove recalcitrant in refusing to accord preferential tariffs. The United States will not draw all their sugar from Cuba and the American colonies. The West Indies, therefore, will have to fall back on the United Kingdom." This colony would be very pleased of the opportunity of reciprocating preferential treatment with the Mother Country, as Mr. Wyatt points out in his letter, but until the Mother Country leads, our hands are practically tied. As for obtaining "*a quid pro quo* for the abolition of the bounties," that would be equivalent to a judge demanding a bribe for administering justice. A reference to the report of the Moseley Commission, and an article on "American Methods" in the current issue of "*Chamber's Magazine*" will confirm what Mr. Wyatt has to say about American machinery.—*(Argosy.)*

HAWAIIAN SUGAR PLANTERS' ASSOCIATION ANNUAL MEETING AND REPORTS.

On November 23rd last, the 23rd Annual Meeting of the Hawaiian Planters' Association took place and in accordance with the usual custom the reports of the various committees were read.

The Report of the Committee on Cultivation was the first submitted. It pointed out that "each plantation has its own conditions to govern its work, the manner of doing it, and its cost." In fact they have every possible condition of tropical cane growing to labour under—high and low temperatures, rocky lands and lands without a stone on them, windy and calm districts, rich soils and poor soils, deep soils and shallow soils, dry districts and rainy districts. In response to a circulated enquiry as to the modus operandi, 36 replies were received from 19 irrigated and 17 non-irrigated plantations.

Where lands are rocky a 14 in. breaker is generally used; where they are not hilly the disc plough is used; and on irrigated plantations

steam ploughs of the "Fowler" make are found the most economical. The advantages of the disc plough were discussed, and it would appear that if this type can be adopted in steam implements, its use on lands free from rocks is merely a question of strength of material. On the plantations of Waialua, Oahu and Ewa a large "Oliver" plough has been introduced for second ploughing. It is a 30 in. plough attached to the Fowler steam apparatus. Where the soil permits, this does excellent work reaching to a depth of from 28 to 30 inches. But it is an expensive job as a set of 20 H.P. Fowler ploughs goes over but five acres or so per diem. At the same time the results obtained fully justify the extra cost. At Ewa the highest yields ever obtained on certain fields were achieved on soils ploughed to 30 in. with these ploughs.

All the plantations where the land will allow prefer to use steam ploughs in the preparation of the soil, as, though costing much more than animal ploughing, the resulting returns are so much enhanced that it is of great financial benefit.

Planting.—The average distance between furrows is 5½ ft. in most parts of the territory. Tops are everywhere preferred for seed, and failing these, plant or good first ratoons are used. The greatest difference exists with regard to the placing of seedling canes. In general the cuttings are overlapped in the poorer, rocky soils, having heavy rainfall: and in dryer localities or richer soils, they are placed either end to end or several inches apart. With an early planting in the warm months of June and July on irrigated plantations, seed is, as a rule, spaced a few inches apart.

Ratooning.—The great preponderance of opinion is that long ratooning is as profitable as plant cane, especially on irrigated lands. Only eight plantations out of thirty-six hold the opposite view. On the other hand, the weight of evidence is against short rattoons as opposed to cutting back.

Hilling-up.—The practice of hilling-up irrigated rattoons is in general favour in Kauai and Maui, as it involves a large return at a small expense. The operation consists in ploughing deeply and loosening soil between the furrows with a 10-inch plough, pulled by two mules hitched tandem fashion, and followed by the spreading of the loose ploughed earth against the canes by means of a V-shaped machine; the rattooned canes are thus on the hilled portion, and the water is applied to the hollow space between the cane rows.

Implements and Cultivation.—In the Ailo district the general practice is to use cultivator and horse plough, and on account of excessive rainfall to fill in furrows and hill-up plant canes as quickly as possible. But in the dryer districts the practice is the reverse of this, as when the evil day of drought comes those canes which are rooted high are the first to suffer. In rattooning on non-irrigated plantations, the endeavour is to plough as deeply as possible between the cane rows in order to thoroughly loosen up the soil.

Varieties of Cane.—The old Lahaina cane is still the stand-by on irrigated plantations, and so far no other variety can claim to have established its superiority for general conditions. On non-irrigated estates Yellow Caledonia has displaced, or is displacing, Rose Bamboo; and in Kohala, Hamakua, and Hilo it is considered the best all-round cane for present cultivation. Rose Bamboo is a deeper rooter than Lahaina on unirrigated plantations; and Yellow Caledonia in its turn is a deeper rooter than Rose Bamboo. On this account the Yellow Caledonia suffers less in dry weather than either of the other two varieties.

Mr. Eckhart, Director of the Experimental Station, in discussing the merits of the different cane varieties wrote "For irrigated plantations, Demerara seedling No. 117 is in my opinion the most promising variety, as at the experiment station field it easily leads all the other canes. On one of the Oahu plantations where it has been tried in competition with Striped Singapore, Tiboo Merd, Rose Bamboo, and Fiji Purple, it yielded from a ton to a ton and a half more sugar to the acre than the other varieties. It is a rather grassy cane, that is characterised by thick stooling, giving heavy tonnage per acre, and by juices of rather low purity except with rattoons, when purity is good. Louisiana Striped has been planted on quite a large scale (about 15 acres, I think) on one irrigated plantation and does very well, that is, fully as well as Lahaina. It flowers earlier and more generally than Lahaina or Rose Bamboo."

It was pointed out in conclusion that the cultivation of cane on cane land in Hawaii is practically continuous and that while burning of trash and leaves is general, it is the exception and not the rule to rest the lands, or to greensoil them by the cultivation of leguminous plants.

Handling and Transportation.—Little has been done of late years to device new methods of handling and transporting cane save in Waialua and Waiakea. At the latter place during the last crop all the cane was put on the cars by means of loaders. These latter are calculated to save 50 men a day and the unloaders 10 men a day. In Hamakua a great deal of lifting to car is done by hoisting a load of a ton at a time at set stations, carting a few miles. On several plantations the wire rope or trolley system has been introduced with gratifying results. Cane can thereby be taken to mill over gulches, through woods, fields, &c., and it works successfully in places where there is no water for fluming, railroads are an impossibility and carting would not pay. The bundles once hooked on, and started on a suitable gradient will go miles to their destination. Amongst other methods of transportation in favour are fluming, rail, portable track, manual or animal power with sleds or carts, waggons drawn by traction engines. It is stated that while it only costs \$2·50 per ton to scientifically manufacture sugar from the cane, it costs \$3·50 per ton

to bring the latter from the field to the mill. There is clearly room for improvement here and some money spent during the next few years in stimulating invention would not be badly invested.

The cost of the various mechanical methods of transport is given as follows: The Waiakea loader costs altogether 36·38 cents per ton for the crop. Fluming in Hilo costs about 42 cents per ton. Hamakua with various methods works out at 45½ cents per ton.

Utilisation of By-Products.—Very few plantations check accurately the value of their waste or by-products. In nearly every case, the losses in manufacture (averaging about 15% of the sugar in cane) are put down as though the valuable constituents of scum press cake, mill ashes, and molasses were lost absolutely, whereas most of the plantations use scum press cake and ashes as fertilisers, and molasses to a limited extent as fertiliser, fuel, or feed. In all mills there is a constant endeavour to reduce the losses, and thereby the value of the by-products is decreased. Bagasse not being classed as one of the latter (as it is used mainly as a fuel to carry on the boiling processes of the factory), the real by-products are waste molasses, scum press cake, and mill ashes.

Distillation of the molasses, the most obvious plan, has so far not been undertaken owing to long-standing prejudice. But there are no valid reasons for objecting to this process, and a paper on the subject by Mr. J. N. S. Williams, who has given the matter much careful study, was of considerable interest.* Mr. E. E. Hartmann, also dealing with the utilisation of by-products, referred to the manufacture of molascuit under Hughes' patents, and gave two analyses of its composition. He said that if molascuit were exported, the ash was lost, the value of the contents being based solely on the existence of carbo-hydrates and albuminous nitrogen; whereas both the sugar and the ashes are saved where spirits is made. Little information seems available in regard to the economical aspect of the manufacture of spirits from cane molasses, though great progress has been made in the distilling industry during the last few years. A distillery might to-day prove a lucrative undertaking, though ten years ago their prospects were far from encouraging. Another simple manner of disposing of the waste molasses was to run it on to the land with the irrigation water. In this way, theoretically, nothing of the fertilizing value was lost.

After weighing all the evidence sent in, the Committee on Utilisation of By-Products concluded that although the bagasse carries with it a large quantity of sugar, it is not altogether a waste product. The loss of sugar can be controlled to a great extent in a well-designed mill. The use of bagasse for making paper is not to be preferred over its use as fuel. Scum press cake is a by-product whose loss can be

* This is reproduced on another page.

reduced to a minimum by proper methods of treatment. Ashes, a by-product containing potash in a soluble form, should be kept dry, and the potash leached out. The molasses presents a more difficult problem. With a reduction in its sugar content by improved manufacture, its value as a by-product depreciates correspondingly. Three methods only suggest themselves whereby this by-product can be profitably disposed of :—

1. By distillation into spirits and the use of the potash resulting from this distillation as a fertiliser.

2. By burning in properly constructed furnaces, so that the full caloric value may be obtained for producing steam, and all the ashes saved for making potash.

3. By using it as food for horses, mules and cattle.

WEINRICH'S NEW PROCESS FOR TREATING SUGAR CANE WITH LIME.

The main points of this new process consist in defecating the juice of the sugar cane before the cane undergoes the ordinary process of milling, thereby leaving the defecation scum in the bagasse and giving an almost instantaneous defecation. This does away with the whole defecation and filter-press plants, and avoids any decomposition of the juice, also giving a high extraction and a purer juice. The cane is finely shredded, then treated with hot milk of lime or lime water, till neutralization or slight alkalinity, and the whole mass heated to 85° C. (185° F.). It is then put through the ordinary milling process and the juice extracted. The bagasse retains the greater part of the impurities, and leaves a juice which is purer and comparatively clear. If necessary, dilute phosphoric acid, carbonic acid gas, or sulphurous acid gas can then be used to reduce the alkalinity and the juice filtered either through a mechanical filter or sand filter.

The following tests made by me in the factory at Chaparra, Cuba, will tend to show the great value of this new process :—

Test No. 1.

(a.) *Ordinary Method.*—500 gms. shredded sugar cane, the juice extracted in spindle-press, and made slightly alkaline with milk of lime, and heated to boiling and filtered.

(b.) *New Method.*—500 gms. of the same shredded sugar cane, treated with 5% boiling milk of lime at 2° Be. (which made it slightly alkaline), and heated to 85° C. on water-bath and juice extracted in spindle-press (not filtered).

(c.) *New Method.*—Same juice as (b.), but the excess of lime precipitated with dilute phosphoric acid and filtered.

	Purity.		Glucose (in solids).
(a.)	87·5	filtered	3·2
(b.)	87·0	not filtered	4·0
(c.)	89·1	filtered	3·6

TEST No. 2.

(a.) *Ordinary Method.*—500 gms. shredded sugar cane, the juice extracted in spindle-press, and made slightly alkaline with milk of lime, and heated to boiling and filtered.

(b.) *New Method.*—500 gms. of the same shredded sugar cane made slightly alkaline with 1·5% boiling milk of lime at 5° Be., and heated to 85° C. on water-bath and juice extracted in spindle-press (not filtered).

	Purity.		Glucose (in solids).
(a.)	90·9	filtered	2·9
(b.)	90·7	not filtered	2·1

TEST No. 3.

(a.) *Ordinary Method.*—500 gms. shredded sugar cane, the juice extracted in spindle-press, and made slightly alkaline with milk of lime, and excess of lime precipitated with dilute phosphoric acid and filtered.

(b.) *New Method.*—500 gms. of the same shredded sugar cane treated with enough boiling milk of lime at 5° Be. to make it slightly alkaline. Heated to 85° C. on water-bath and juice extracted in spindle-press. Excess of lime precipitated with dilute phosphoric acid and filtered.

	Purity.		Glucose (in solids).
(a.)	82·2	filtered	5·2
(b.)	84·0	filtered	4·2

The average solutions were at about 15° Brix. In several previous experiments it was found that using thin milk of lime instead of lime-water, and heating to 85° C. gave the best results, consequently these were used in the tests.

The juice extracted from the cane that was treated with dilute milk of lime, and heated to 85° C., was in all cases cloudy, but showed plainly that the bagasse had held back a large amount of the precipitate caused by the lime. On addition of a little dilute phosphoric acid to neutralize the excess of lime, the same gave a nice clear solution which filtered well.

Thus it is plainly seen what a decided improvement this new method is over the ordinary methods now in use.

A. W. HOPPENSTEDT, in *Louisiana Planter.*

HAWAIIAN SUGAR PLANTERS' ASSOCIATION.

Synopsis of the Annual Report on Machinery.

Cost of Manufacture.—Mr. Stodart recommended that the Secretary of the Planters' Association present at the annual meetings a report, in tabulated form, on the cost of operations (manufacture), including supplies, from the Hawaiian factories, for the purpose of determining the relative value of the various machine installations in relation to their efficiency.

Buildings.—He also advocated reducing the cost of new factories by eliminating useless ornamentations, and excessive height, and preferred to place the crystallizers on the ground floor and empty their contents into the mixers above by means of compressed air, thereby saving that floor in height.

Cane Unloaders.—He stated that the total cost of unloading cane at McBryde Mill, from moving the loaded cars from the storage tracks to delivering the empty cars on the return tracks, including weighing, was 2·69 c. per ton of cane, a saving of 35% over hand labour, using the Mallon-Bodley cane unloader and handling on an average 735½ tons of cane per 24 hours. Mr. J. N. S. Williams stated that the cost of this work at Puunene Mill was 2·5 c. per ton of cane, using Gregg's machine, with about 1,100 tons cane per day.

Evaporators.—Mr. Stodart stated the important factors in the proper construction of evaporators, and claimed that the triple-effects at McBryde Mill supply most of these conditions. "Efficiency" of heating surface does not necessarily mean economy, except in the first cost. The film evaporator came nearest perfection as regarded the small amount of juice under operation, the large liquid surface, and good circulation, but Mr. Stodart thought it had drawbacks which partly counteracted these advantages. The main advantage of the McBryde evaporators consisted in the construction, which created a large liquid surface by ejecting the juice from the vertical tubes to a height of from 12 inches to 18 inches, and the streams only combined when the evaporation was completed in that cell. A table showed the effect of scaling on the efficiency during a week's run, when the work was practically uniform for the entire week, and the lbs. of water evaporated per sq. ft. H. S. per hour was proportionate to the quantity of juice treated—an average of 8·3 lbs. in this case. A table of the average work for the season shows: Steam pressure, 6 lbs.; reduction, 69·8% by weight; 7·93 lbs. water evaporated per sq. ft. H. S. per hour. Mr. Stodart also presented a table showing evaporator work in a number of other factories, furnished by the managers, but as this table was very incomplete, and the reports at variance with one another, no reference was made to it in this resume. Mr. Stodart suggested that accurate data on evaporation be regularly furnished

by the various factories during the season and presented at the annual meeting.

Sugar Dryers.—The Hersey Hot Air Dryer and Granulator had been in operation during the last season on two of the Oahu factories, and were considered good investments. Similar dryers would be in use in other factories during the coming season. The arrangement and construction of these machines were commonly used in other sugar factories, but with the double capacity of heater.

Automatic Bag-Filling and Weighing Machine.—Mr. Stodart believed these would only work satisfactorily on dried sugars, and should embrace an automatic sewing attachment. A machine was on the market which would fill, weigh, count and sew 75 bags per hour, with the attention of one man and a boy, and could be arranged in connection with a bag conveyor direct to the cars.

Pumps and Pumping.—Mr. Stodart regretted not having reliable data on the comparative cost of pumping with the various styles of irrigating pumps, and the saving effected by using oil instead of coal, and suggested that such accurate data be presented at the annual meeting. He stated that the average cost of pumping at the McBryde Plantation, using coal, and including labour, repairs, and superintendence, was:

Risdon Iron Works 10 million gallon flywheel pump and Heine boiler, with economizer, 4·48 c. per million foot gallons.

Riedler 10 million gallon flywheel pump, with B & W. boilers, and no economizer, 4·65 c. per million foot gallons.

Worthington 6 million gallon vertical pump, with Stirling boilers and no economizer, 7·05 c. per million foot gallons.

All these pumps have triple-expansion and surface condensing engines.

SPECIAL PAPERS.

Mr. Geo. W. Connon: This paper treated the subject of water-driven centrifugals in an instructive and interesting manner, stating the calculations to be used in order to determine the proper speed, water pressure and power required on the motor. After a lengthy, detailed description of the difficulties experienced with the 40-inch machines installed in the McBryde factory, and the changes made to piping and pumps, the final results were that with 200 lbs. per sq. in. pressure on the water for the centrifugals drying first sugars, and 160 lbs. on the water for the centrifugals drying second sugars, with a pump piston speed of 50 ft. per min., there was no difficulty in drying the sugars satisfactorily. Mr. Connon reasoned out mathematically that as nearly all 40-inch centrifugals used there have 20-inch motor wheels, and use about one gallon of water per second, the proper pressure to insure the maximum efficiency should be 205 lbs. per sq.

inch. He recommended as the most suitable pump a duplex, outside-packed plunger, flywheel pump, with automatic "cut-off" engine and hydraulic governor. Such a pump will use 30 lbs. steam per indicated H. P. per hour, while a direct-acting pump would use 100 to 150 lbs. steam per indicated H. P. per hour.

Messrs. W. G. Hall and W. A. Ramsay: These gentlemen have invented an automatic, continuous centrifugal, which was fully described in *The Scientific American*, May 23, 1903. The advantage claimed by the inventors is to continuously charge and discharge the machine while it is rotating at the proper speed, thus obviating the waste time and energy in stopping and starting for each charge. It is to be hoped that this ideal aim of so many inventors is here realized. So far only an experimental machine has been tried at the works of Messrs. Catton, Neill & Co., Ltd., with very promising results. A more perfect machine is now being built.

Mr. James Steel: This paper gave a comparison between the mill work as practised in Fiji and Australia and in the Islands here. The most striking difference lay in the application of maceration water. In those countries, the three three-roller mills were placed with a long distance between them and, therefore, driven by three engines, and the bagasse is conveyed through a bath of hot water or diluted juice from the last mill. The bagasse is immersed for 10 to 12 minutes, instead of 1½ minutes as there. Mr. Steel made the general statement that with a shredder and a six-roller mill as high extraction is obtained by this method as with our nine-roller mills and crusher, and supported this statement with some simple calculations, but did not, however, mention the fuel question. He preferred the separate engines, as thereby the mill speeds can be regulated, and believed the mill hydraulics would compensate for variations in feed. In those countries the second and third mills run more slowly than the first mill, and are fitted with force feeder, and engines often "pull up" with too heavy feed. The quadruple effects are worked with a pressure of 31 lbs. to 34 lbs. on the first cell, which also supplies steam for other boiling house purposes. The juice is filtered through bagasse instead of sand, and this bagasse is passed through the mills after being used.

Mr. James W. Donald: This interesting paper on "Clarification" described a somewhat different method used in the McBryde factory to what was generally used in other factories there, and should have been referred to the Committee on Manufacture for the proper presentation it deserved. The machinery used consisted of lime slacking vats, lime mixer with stirrer, pump, sulphurizer, juice heater, circular defecating tank with steam coils, and storage tanks for settlings, etc. The *modus operandi* differed from that followed in other Hawaiian factories, principally in the liming of juices, which

was done by pumping very dilute milk of lime as maceration water after first mill, whereas water was used after the second mill. The greatly over-limed juice from the second and third mills mixed with the normal, unlimed juice from first mill and the mixed juice was pumped to the upper end of a sulphurizing tower, from whence it flowed zig-zag to the lower end while being charged with sulphur fumes. It was then heated from 190° to 200° and entered the circular defecating tanks (clarifiers) where the juice was brought to the proper temperature and left to settle. Sulphurating was only used when needed. The settlings were heated, limed and pumped to the filter presses without being perceptibly diluted. The cake was washed in the press in the usual manner, and contained when discharged: Max. 3·5%; min. 1% and average, 2·75% sugar.

Mr. J. Anderson: Mr. Anderson contributed two interesting papers. The first treated the subject of centrifugals, and described in detail the construction of the machines built by Messrs. Watson, Laidlaw & Co., Glasgow, Scotland. Mr. Anderson compared these machines with those of American make, and stated that while his experience with the latter was confined to the Makaweli and Kealia factories, he had had good opportunities to study the make of the Scotch machines in the Glasgow works of the above firm. After a detailed description of both styles, he came to the conclusion that he preferred the Scotch machines, especially on account of the greater ease with which they can be oiled and examined, the inside bushing being bronze instead of white metal, and the lesser weight of the basket, which is 833 lbs. in the Scotch, and 1,070 lbs. in the American machines. Then the spindle washers were, in his opinion, more carefully made in the Scotch machine, and carried only 271 lbs. per sq. in. when loaded, whereas the American machine washers carried 438 lbs. Mr. Anderson next described the recent improvement of substituting steel ball bearings for washers. He apparently gave preference to the water-driven machines with the automatic "cut-off" attachment, which he described. He also stated that electrically-driven machines were now being made, and mentioned two different types, but did not attempt to discuss the relative merits of this to any other form of motive power, which largely depended upon local conditions. The "floating spindle" machine was interesting, in that neither washers nor balls were used. Oil was pumped under a specially-constructed spindle bearing at such pressure as would lift the whole machine, which then revolved on an oil column. This form was used for very large machines. Mr. Anderson described a self-discharging centrifugal with 48 in. diameter and 30 in. deep basket, with sloping bottom and distributing movable cone on the spindle. The machine was charged whilst in motion but stopped for discharging, whilst the sugar is not touched.

Mr. Anderson's second paper dealt with various machine installations at the Kealia factory. He was not in favour of the Kilby vacuum pans there, on account of the difficulty he experienced in draining the coils, the height of belt, and inaccessibility for making repairs to coils. He objected to the sand filters in that factory (they are large tanks with a double perforated bottom on which the sand lies, and are not of the "Standard" vertical type), and preferred the settling of the juice in tanks. The Wellner-Jelinek evaporator worked well, but Mr. Anderson thought this was due to its large heating surface—12,000 sq. ft. The considerable entrainment was checked by the application of extra baffle plates and save-alls. Mr. Anderson believed there was no hard and fast rule for setting mill rollers, except that they should be adjusted so that the mill is *just able* to take the begasse from the preceding mill without choking. He preferred hard material in the rollers, as they became loose if soft, and the application of bands shrunk on the shafts at the ends. He also recommended water-jacketted bearings for the purpose of cooling the journals. The temperature of maceration water should be from 100° to 120°, and applied by a force pump with 50 to 60 lbs. pressure through a small pipe under the bagasse as well as on the top. Of cane unloaders, Mr. Anderson liked the "Froelich" machine, which easily unloads 1,000 tons of cane in 24 hours, but he did not state with how many men and at what cost per ton of cane.

Mr. E. Kopke: Mr. Kopke contributed to the general subject on evaporators a carefully-prepared report, with diagrams, on some tests he had conducted with a "Lillie" quadruple-effect. These tests were made under adverse circumstances and do not indicate normal work, and should, therefore, be withdrawn, together with the evaporator table mentioned before, and, after new tests have been made, incorporated with a general report on this subject, to be presented at the next annual meeting.

Mr. L. L. Mann: Mr. Mann described a water-measuring machine he had invented, and which had been in successful operation in one of the main water-ways at the McBryde Plantation since January 1st, 1903. It was designed for automatically recording every five minutes the true depth of the water flowing over a weir, so by reference to a weir table the quantity of water flowing for any given time may be ascertained. The apparatus was very simple and inexpensive. Mr. Mann stated its cost to be about $30·00, including the housing for it. It consists of a combination of clockwork, an electro-magnet and a pencil, which automatically traces a curved line on a suitably-ruled record paper, while a float on the water indicates the variations in depth.

Mr. George Ross: This paper treated of automatic bagasse feeding as practiced at Hakalau, but Mr. Ross said he knew of but little new which has been introduced in this line during the last year. The principal feature of newly-built furnaces is that they project in front of the boilers so as to insure the maximum temperature of the flame when reaching the entire boiler bottom; also the increased space under the boilers. All the Hakalau boiler settings have been gradually changed to this plan, resulting in increased efficiency. Mr. Ross described the arrangement of the automatic bagasse conveying and firing at Hakalau factory, which, however, differs but little in the central points from what is in use in other modern factories here. The saving over hand firing, he claimed, was eight men per 24 hours (four men in each shift) for four furnaces. He also mentioned the "Simon" automatic sack-filling and weighing machine imported by the Honolulu Iron Works as a sample, and believed this was likely to come into general use, insuring more accurate weighing and saving labour.

Mr. E. W. Cant: Mr. Cant submitted a description of a battery of eight crystallisers installed in the Onomea factory. These were made from eight old boiler shells on the plantation and with plantation help. The dimensions are 6 ft. by 12 ft. These machines differ from other such installations in these islands in that the entire shell evolves one revolution in three and three-quarters minutes by means of a worm and worm wheel, and were driven either by an electric motor or an engine. In the interior is bolted to the shell, diametrically located, two curved plate supports extending the entire length of drum, and to these are fastened a 150 ft. long 1½ inch galvanised pipe coil, with its ends projecting through the centre of the drum heads with trunnion boxes, as shown in sketch. By passing hot or cold water, or steam, through this pipe, the proper temperature was adjusted, a very important point in obtaining the best results.

Mr. Cant described a screw conveyor for the removal of press cake, a contrivance used in several factories, and also how he pulverised 98% of the total press cakes for fertilising purposes. Three thousand tons such material was procured by a crop of 13,500 tons sugar. Mr. Cant also described and exhibited two models of improved link-belt chains and sprocket wheels to be used for intermediate apron conveyor in mills. The object was to prevent fine bagasse packing into the pockets of the links, causing the breakage of the same. This trouble is, however, obviated in all later built mills by having no teeth on the lower sprocket wheels, but only on the upper driving ones.—(*Planters' Monthly.*)

THE UTILIZATION OF BYE-PRODUCTS RESULTING FROM THE MANUFACTURE OF RAW SUGAR FROM SUGAR CANE.

(From the *Planters' Monthly.*)

The only bye-products resulting from the working up of sugar cane are:—First, bagasse or the crushed cane after the bulk of the sugar has been extracted, and second, molasses, or the gummy viscous syrup remaining after as much crystallizable sugar has been recovered from the cane juice as the methods employed will admit of.

Bagasse containing from 3% to 6% of sugar on its weight, and 40% to 45% of water is valuable fuel, and although attempts have been made, notably in the Southern States, to use bagasse or cane fibre for the manufacture of paper stock, no marked success has yet attended the ventures in this direction.

Bagasse, as delivered by a good nine roller mill, is worth as fuel delivered into the furnace one-third of its weight in coal, and since it can be handled automatically, and fed to suitably arranged furnaces in a very regular manner, it would appear that the greatest value of bagasse is obtainable when used to provide steam for the factory which produces it.

Waste molasses presents at the present day an economic problem of no small importance.

For every ton of cane ground in these islands an average of 50 pounds of molasses is produced, and since the total cane ground during the crop of 1903 reached 3,500,000 tons, it follows that 87,500 tons of molasses containing not less than 30,000 tons of crystallizable sugar were to all intents and purposes wasted.

Molasses contains besides the crystallizable and uncrystallizable sugars, various salts, amongst them potash in some quantity.

The sugars can be utilized in the manufacture of spirits, and the potash can be recovered after the spirits are distilled off.

The question as to whether this can be done at a profit is an open one; certainly under the present market conditions, and internal revenue regulations, spirits cannot be made and sold at a profit in the United States, and mainly for the reason that the alcohol resulting from a beet or cane molasses, which has been exhausted of its sugars to the low point now demanded in modern sugar factories, is not adapted to blend with other liquors for direct consumption as it introduces an objectionable flavour, and thus the greatest market for spirits resulting from molasses is closed.

Alcohol is used in the manufacture of explosives, especially smokeless powder, varnishes, perfumery, and in chemical laboratories, also in soap factories to a small extent. Alcohol is also used as a fuel for

automobiles and small motors, and has a calorific value about that of coal, with the advantage that it can be used in gas engines, and burns completely without leaving any residue as do gasoline or other hydro-carbons.

Alcohol can be used for lighting purposes, and it is reported that alcohol lamps, using a mantle of the Welsbach or Auer type, produce a light equal to electric incandescence at about half the cost, and without odour or other unpleasant features.

But for fuel and lighting purposes the United States internal revenue tax of $1·10 per proof gallon is prohibitive, and until the people of the United States demand cheap alcohol for the purposes of lighting and fuel, there is no hope of utilizing our waste molasses in this direction.

A distillery to produce 5,000 gallons of 96% alcohol per day, would cost put up in running order in the Hawaiian Islands about $200,000·00; would require a force of about 35 men, with a monthly pay roll of about $2,500·00; the monthly expenses for fuel and other supplies, &c., not including the raw molasses or containers would be about $5,000·00.

The value of the containers (if casks) would reach nearly $4,000·00 per month when working at full capacity, and the molasses required to produce 5,000 gallons of 96% alcohol per day (say 14,000 gallons) would cost at 3c. per gallon delivered to the distillery $420·00 per day, or say $11,000·00 per month.

We have then one month's expenses:—

Pay roll	$2,500·00
Fuel, supplies, &c.	5,000·00
Containers for 130,000 gals. spirits..	4,000·00
Molasses (raw material)	11,000·00
Wear and tear and interest at 10% per annum, per month	1,700·00
	$24,200·00

Output 130,000 gallons 96% alcohol. Cost per gallon 18·6c.

If this 96% alcohol were to be put on the market anywhere outside of the United States, say Japan, it would come into competition with German spirits of the same quality, which are laid down at the present time in Yokohama in bond for 27½c. per gallon, done up in 10 gallon cases, said price including cost, freight, insurance, containers, and manufacturers, profit. Deducting freight, insurance, and containers, the cost of the alcohol from Germany works out at 19½c. per gallon, which confirms the above estimate of cost of manufacture in this country, and shows that the margin of profit is too small to warrant reaching out for foreign trade in this direction. To recover the potash after the sugars have been removed by distillation, the liquid from the distillery must be evaporated to dryness, and the residues calcined in a suitable furnace, leaving the values available as caustic potash; but

as the percentage of potash does not exceed $4\frac{1}{2}$ in Hawaiian molasses, the cost of evaporating the liquid and calcining the residues, will not be met by the cash value of the product, so that this will not be a paying proposition.

Molasses has a value as fuel, and when properly burnt is about equal to bagasse.

There are several ways of burning molasses in use in this country, but it is very questionable if the full thermal value is obtained.

The simplest way is to sprinkle the waste molasses on the bagasse as it leaves the last mill on its way to the furnaces. When molasses is fired in this way at the rate of about 50 lbs. molasses per ton of cane ground, it burns readily, and is of marked assistance to the bagasse as fuel. A greater quantity than this, however, tends to clinker the furnaces, and instead of being a help is a hindrance to the fuel qualities of the bagasse.

Another way is to atomize the molasses by steam as fuel oil is atomized. This is successful in burning the molasses, but as it takes $1\frac{1}{4}$ lbs. of steam to atomize 1 lb. of molasses, which when burnt to the best advantage only produces $2\frac{1}{2}$ lbs. steam, it is readily seen that there is no gain in this method over that of sprinkling the molasses on the bagasse, which latter method is by far the simpler.

Another method is that of burning the molasses in a retort furnace specially adapted for the purpose, means being provided for saving about one-half of the potash, which is recovered in the ashes. This seems to be the best method of utilising molasses as fuel, but sufficient data is not yet available as to the results.

In all cases where molasses is burnt with the bagasse, a certain portion of the potash is available in the ashes, which when put upon the land, yields results, the cash value of which is difficult to estimate.

The best price which ordinary waste molasses in quantity would fetch in San Francisco is from \$5·00 to \$6·00 per ton delivered. A ton of molasses contains 166 gallons, and at \$5·00 per ton would be worth 3c. per gallon delivered; it would cost at least \$3·00 per ton to deliver molasses in San Francisco, or 1·8 c. per gallon, leaving 1·2 c. per gallon as the net value of a gallon of molasses to the seller here, and since the fuel value of a gallon of molasses is equal to 4 lbs. of coal, which is worth at present prices ·3 c. per lb., it appears that burning the molasses is as good a way of disposing of the waste as selling it, which involves some capital expenditure for containers and arrangements for storing.

But the average waste molasses contains some 35 % of sugar, which is equivalent to a little over 4 lbs. of pure sugar per gallon; and it is almost certain that by improved methods of clarification and filtration of the molasses, a large percentage of this loss could be recovered, but a special plant would be required, and it is doubtful if it would pay, excepting in factories of very great capacity, which concerns might

purchase the waste molasses from smaller factories at a price based upon the sugar content, and work it in with their own products, in which manner it is quite possible that a substantial saving would result.

Molasses diluted with water, and run upon the land is said to have value as a fertiliser; no figures, however, are available. The only fertilising value the molasses can have lies in the potash content, as the nitrogen in molasses is a very small quantity and probably is lost in dilution and exposure to the atmosphere, going off as ammonia.

A brief summary then shows that bagasse as a bye-product of cane is more valuable as fuel than for any other purpose; while waste molasses can be converted into spirits for use as a fuel and for lighting purposes at a small profit, provided that the fiscal regulations permitted, and the American market demanded such. At the present time, however, the best use to put molasses to, exclusive of that small amount which is fed to live stock, is to use it as fuel, or as fertilizer.

There is, however, no doubt but that efforts will be made in the near future to still further exhaust the waste molasses of its sugar contents, since the gross loss amounts to the very large figure of some 30,000 tons of sugar per annum.

J. N. S. WILLIAMS.

BARBADOS AND PORTO RICO MOLASSES.

On the occasion of a recent visit of Sir Daniel Morris, the Commissioner of Agriculture for the West Indies, to the United States to make enquiries about the cotton industry, it was suggested to him that he might in addition get some information with regard to the trade in molasses carried on between the West Indies and the U.S.A., and thereby help the Barbados merchants and planters to get the best value for their shipments. It was also suggested that he might visit Porto Rico so as to ascertain the cause of the preference accorded to Porto Rico molasses in the United States and Canadian markets.

While not finding it advisable to pay a visit to Porto Rico as suggested, Sir D. Morris nevertheless found it possible to obtain valuable information in New York and elsewhere; and a summary of the same is given in a pamphlet published by the Imperial Department of Agriculture for the West Indies entitled "Barbados and Porto Rico Molasses."

In Porto Rico there are for practical purposes but three grades of molasses, "Fancy," "Choice," and "Prime," of which "Fancy" is the highest grade, and is prepared in some instances by mixing syrup made from cane juice with the best quality molasses obtained from muscovado sugar. "Choice" molasses, which is the second grade, corresponds to Barbados molasses, though of a considerably better colour.

Molasses is shipped from Porto Rico in hogsheads containing about 150 gallons, in puncheons of about 110 to 120 gallons, and in 50-55 gallon barrels. The two former containers are made of best new packs, and bound round with strong locked wooden hoops as well as four iron hoops. The locking of the hoops was stated to be a matter of importance; the buyers objected to the Barbados method of tying the hoops with rope yarn as this style is not so strong. Barrels are preferred to hogsheads and puncheons, as the two latter are unsaleable when empty. The barrels on the other hand are used two or even three times for the carriage of molasses, and are then sold for putting tallow in, and afterwards for tar.

Barbados molasses was stated to be formerly as good as Porto Rico molasses, but of late it has tended to turn acid. This was possibly caused by the planters using old packs to make the puncheons of. Good molasses should be light red in colour, non-fermenting, and possess good baking qualities. A great deal of the molasses in the United States is used for making ginger bread and cakes of various sorts. For this reason, the users prefer the molasses slightly acid as it liberates the carbonic acid in the bicarbonate of soda mixed with the flour, causing the cakes to rise. This property is known as the baking quality of molasses.

The majority of Barbados molasses cost f.o.b. at Barbados about 23½c. per gallon, made up as follows, viz.: molasses 18c. per gallon, puncheon 4c. per gallon, stowing on board, etc., 1c. per gallon, and bank charges ½c. per gallon. The highest price paid for Porto Rico "Fancy" molasses was 27c. per gallon f.o.b., the average price being 24c. to 26c. per gallon. Porto Rico "Choice" molasses, which, as stated above, corresponds somewhat to Barbados molasses, cost f.o.b. 21c. per gallon. The value of a gallon of Porto Rico "Fancy" molasses this year in New York was about 35c. per gallon, while Barbados molasses was worth about 28c. per gallon, the difference being therefore about 7c. per gallon in favour of Porto Rico molasses.

Porto Rico "Fancy" and "Choice" molasses and Barbados molasses contain on the average about 52 per cent. of saccharose, the minimum being about 47 per cent. and the maximum 56 per cent.

The duty in the United States on molasses containing less than 56 per cent. of saccharose is 3c. per gallon, and on that containing 56 per cent. and upwards it is 6c. per gallon, wine measure.

From the information obtained in answer to various questions, Sir D. Morris came to the conclusion that there was a good market in the United States and Canada for properly graded and suitably packed Barbados molasses, and that eventually it might be possible to make practically the whole of the sugar crop into syrup, as under present prices every pound of sucrose sold as sugar brings in 1·45 c., and every pound sold in molasses 2·09 c.

Sir D. Morris' report concludes:—

"On estates where vacuum pans are in use, we are of opinion an excellent table syrup could be produced by decolorizing the cane juice with sulphur fumes, then adding lime nearly to neutrality, evaporating the juice in the tayches to thin syrup, adding, if necessary, some citric acid, settling the syrup to allow the impurities to subside and afterwards concentrating it in the vacuum pan. Syrup made in this way should be of a nice golden colour and worth as much as the best Porto Rico 'Fancy' molasses. A similar process would be applicable also in the case of Central Factories. In addition a properly equipped factory would recover at least 25 per cent. more of the saccharose in in the canes that is now lost.

"All syrups should preferably be put up in barrels holding about 50 to 55 gallons in the manner adopted by Dr. Wiley, who first of all steams out the barrels and puts lighted sulphur inside, tightly driving in the bung. The sulphur continues to burn until all the oxygen in the barrel is consumed; the remaining bits are then taken out and the barrels filled with syrup. He informed us that a barrel of syrup so treated had kept quite good for many months in spite of the fact that it had been opened several times for samples to be withdrawn."

A NEW PROCESS FOR PURIFYING DIFFUSION JUICE WITH A MINIMUM OF LIME.

By M. J. Zamaron.

Our process deals with the treatment of diffusion juice with a certain amount of gelatinous alumina ($Al_2O_3nH_2O$) when limed and heated.

This treatment produces a strong defecation which is followed by an excellent and rapid filtration. The sediment retained in the filter cloths is easily cleaned off with the complete exhaustion of the sugar. The alumina, being insoluble in the sugar juice, coagulates all the organic matters contained in the diffusion juice; the precipitation is especially pronounced in the presence of a determined quantity of lime. Added in feeble doses or in excess, this alkali fails to produce the same cleansing power; the filtration is poor and the syrup turbid.

The sediment obtained by the first filtration has a blackish and clotted appearance; it is formed of aluminate of lime and organic matter from the beetroot. On drying and incinerating this precipitate, a mixture of carbonate and aluminate of lime, completely soluble in HCl. is obtained.

As a result of the strong defecation produced by the above treatment, the work of carbonatation is greatly facilitated. After filtration, the juice is given the complement of the quantity of lime needed for the first and second carbonatations. The saturation of the juice is carried out with ease and at a relatively low temperature.

The simplicity and advantages resulting from the employment of this process should place it on an equality with any that has yet been attempted up-to-date, if only it can be found possible to manufacture commercially the gelatinous alumina at a price such as will allow it to be used in the proportion which we have employed for obtaining the greatest purification with a minimum of lime. This gelatinous alumina is a neutral body possessing a remarkably efficacious clarifying power. Its application in the working of juices does not give rise to the formation of any salts or acids as was the case, for example, in the Lehmkuhl process. Consequently we have a much better purification than would be the case with a juice feebly limed and submitted to saturation with carbonic acid for getting rid of the organic matter from the beetroot. From the experiments which we have carried out (the results of which are given further on), we think that if the chemical industry can succeed in selling this product at a price of 10 fr. per 100 kg., it could be advantageously adopted, for then the purification of the juice would be accomplished with far less lime than is used in present-day practice. In fact it is clearly apparent that the employment of alumina will result in a saving of two-thirds of the lime: this implies a liming of less than one per cent.

The tests were as follows:—

First Series. Diffusion juice + 15 gr. $Al_2O_3nH_2O$ per litre + n of lime; heated to 80-85° and filtered.

Filtration rapid and juice very clear.

Lime added for first and second carbonatations.

	Alkalinity per litre of juice (CaO).	
	Phenol.	Tournesol.
Before filtration	3·0	3·4
After ,,	1·8	2·2
Heating 75-80°.		
Before first carbonatation	3·2	3·5
After ,, ,,	0·6	0·85
Heating 70-75°.		
Before second carbonatation	1·2	1·50
Heating 95-98°.		
After second carbonatation	0·25	0·40 (Ph.)

the actual quantity of lime added for the clarification being therefore 0·5 per 100.

	Initial juice.	Juice after treatment.
Density	1049·1	1052·9
Brix	12·30	13·20
Sugar per 100 cc. juice	10·51	12·36
,, 100 gr. ,,	10·01	11·73
Reducing substances per 100 cc. juice	0·27	0·00
,, ,, ,, sugar	2·56	0·00
Quotient of purity	81·3	88·86
Saline quotient	20·5	29·40

These tests were carried out on two litres of syrup for each operation, the same being taken from the mean diffusion juice produced in the usine in the course of work. The analyses of the products corresponding to an ordinary working of 70,000 kg. of beets gave us the following results:—

	Alkalinity per litre of juice (CaO). Phenol.		Tournesol.
Heating up to 80°.			
Before first carbonatation..	14·5	....	15·00
After ,, ,, ...	1·12	....	1·40
Heating 70-75°.			
Before second carbonatation	4·50	....	4·75
Heating 95-98°.			
After second carbonatation	0·25	....	0·33

thus the quantity of lime actually added equals 1·8 per 100, an increase of 1·3 per cent. over the alumina process.

	Initial juice.		Second carb. juice, Filtered.
Density	1048·3	....	1046·0
Brix	12·12	....	11·58
Sugar per 100 cc. juice..	10·39	....	10·59
,, 100 gr. ,, ...	9·90	....	10·12
Reducing substance per 100 cc. juice..	0·28	....	0·00
,, ,, ,, sugar .	2·70	....	0·00
Quotient of purity..	81·6	....	87·3
Saline quotient	20·32	....	27·95

From the first test we see that the alumina treatment gives superior clarification over the ordinary lime process in that so sma[ll] a quantity of lime is used.

Second Series. Diffusion juice + 20 gr. $Al_2O_3nH_2O$ per litre + n lime; heated to 80-85° and filtered.

Rapid filtration and juice of fine colour.

The residue, of porous composition, was washed with hot water in a relatively short time.

	Alkalinity per litre of juice (CaO). Phenol.		Tournesol.
Before filtration..	6·00	....	6·40
After ,, ...	2·90	....	3·20
Heating 75-80°.			
Before first carbonatation..	6·10	....	6·50
After ,, ,, ...	1·00	....	1·30
Heating 70-75°.			
Before second carbonatation	1·70	....	2·00
Heating 95-98°.			
After second carbonatation	0·20	....	0·35

Actual amount of lime added for clarification (ph) = 0·99 per cent.

	Initial juice.		Juice after treatment.
Density	1049·3	....	1059·8
Brix	12·35	....	14·80
Sugar per 100 cc. juice..	10·69	....	13·99
,, 100 gr. ,, ...	10·18	....	13·20
Reducing substance per 100 cc. juice..	0·20	....	0·00
,, ,, ,, sugar..	1·87	....	0·00
Quotient of purity..	82·4	....	89·17
Saline quotient	21·74	....	30·70

For this test we took a sample of juice corresponding to a two hours' diffusion; this is why the purity of the juice coming from a mean working up of 12 hours does not agree with that of the juice submitted to treatment by alumina as the following analysis shows.

Ordinary working up of 12 hours (70 tons of beets), results of mean factory samples:—

	Alkalinity per litre of Juice (CaO)		
Heating 80°	Phenol.		Tournesol.
Before first carbonatation	15·50	..	15·80
After ,, ,, ...	1·10	..	1·40
Heating 70–75°			
Before second carbonatation..	5·00	..	5·30
Heating 95–98°			
After second carbonatation	0·30	..	0·42

Actual amount of lime added = 1·94%, an increase of 0·95% on the alumina process.

	Initial Juice.		Second Carb. Juice filtered.
Density	1049·0	..	1043·8
Brix	12·28	..	11·05
Sugar per 100 c.c. juice	10·33	..	10·02
,, ,, gr. ,, ...	9·84	..	9·59
Reducing substance per 100 c.c. juice .	0·20	..	traces
,, ,, ,, ,, sugar.	1·93	..	,,
Quotient of purity..	80·1	..	86·7
Saline quotient	19·76	..	27·16

The second test gives us the following figures for definite clarification:—

	Quotient of Purity.		Saline Quotient.
Alumina process	6·77	..	8·96
Ordinary liming process in vogue .	6·60	..	7·40

The increase in purity, although of little importance, remains in favour of the alumina process.

(To be continued).

THE PROGRESS OF EXPERIMENTAL SUGAR BEET CULTURE IN THE UNITED KINGDOM.

At a meeting of the Society of Arts held last month a very interesting and valuable paper was read by Mr. A. R. Sennett on "Garden Cities in their relation to industries and agriculture." A considerable proportion of the paper was devoted to figures and facts relating to experimental sugar beet culture in the United Kingdom, and giving as they do a concise record of what progress has been achieved during the past few years, we think it worth reproducing them in extenso, save for voluminous tables which form a supplement. The chair at the meeting was taken by the Earl of Denbigh, whose successful attempts at beet cultivation on his Warwickshire estates have been already brought to the notice of our readers.

Mr. Sennett said:—

"I now desire to direct attention to another valuable result to accrue from decentralisation brought about by the disposal, throughout the country, of hygienic cities, limited as to population, and each provided with its girdle of market garden and agricultural land. This effect—of enormous national importance—would be due to the so-much-to-be-desired *interweaving of agricultural with urban industry*, such re-adjustment of terrestrial collocation of populace would render possible.

To explain this, I think I cannot do better than take a concrete example of such interweaving; this I will do in connection with an industry—unhappily at present non-existent in our country—albeit of vast importance to other nations, one typically illustrative of the interweaving to which I refer.

Through the instrumentality of the recently concluded Sugar Convention—a laurel in the crown of our present Government—it is now practicable to re-introduce into Great Britain the important industry of sugar manufacture, an industry, through singular neglect, we have allowed to become gradually and entirely extinguished. Very cursory reflection will serve to show the great value of the interweaving of factory industries with agriculture, but there is nothing existing in our own country at the present moment in any way comparable in national importance, with the mutual interworking practicable in regard to the sugar industry, and I venture to bring it forward for the very earnest consideration of financiers and the well-wishers of our nation.

Happily, in regard to the agricultural side, all the necessary experiments have already been gone through. Happily, moreover, the trials and tests have proved thoroughly and gratifyingly successful. As to the industrial side, absolutely no difficulty presents itself. It will, therefore, be only necessary for me to touch upon the agricultural department of the vast industry, viz., sugar-beet culture.

That the experimental stage has been successfully passed through, is due to the hearty co-operation of a number of our leading agricultural authorities with an expert who has displayed singular energy and perseverance in the accomplishment of his object. I refer to Mr. Sigmund Stein. The results of the labours of these pioneers I am enabled to lay before you in tabular form, and I hasten to add that, by their laudable work, they have been able to explode entirely the fallacy that the land and climate of the British Isles is unsuited to beet culture. Those who seem to delight in raising difficulties and in endeavouring to defeat efforts to increase the prosperity of their own country have either scouted the notion or pointed out, entirely without authority, that sugar-beet could, at most, be grown only in our southern counties. I will ask you to glance at Tables A and B (Supplement),* from which you will learn some surprising facts. In the first place you will observe that far from the successful culture being confined to our southern counties, sugar-beet culture has been successfully carried on from Hampshire in the south of England to Aberdeenshire in the north of Scotland; whilst in Ireland the results have been thoroughly satisfactory. It is observable in regard to beet culture that science within reason has as much to say as the sun, or the latitude. We see, for example, in regard to the south, that, under the able supervision of Mr. Moens, the Hampshire yield was the excellent one of 19 tons for a crop raised in 149 days. But if we go to the other extreme, we see in the north an excellent yield was obtained in exactly the same number of days; the northern yield, however, fell short of the southern by some 20 per cent., but then one must carefully observe the fact that the degree of culture also fell short. In the first place the amount of farmyard manure put on to warm the land was only one half; whilst the more scientific or specific treatment was not had recourse to at all. What the effect would then have been is deducible from another Scottish test (Table A, No. 39); there we see that a treatment by dissolved bones immediately raises the yield from 15 tons up to 17 tons, the number of days remaining substantially the same. Excessive rainfall, moreover, it is gratifying to observe in regard to sugar-beet farming proves no formidable enemy, for we find in the west of Ireland the crop can be grown at good speed and with a fine return by means of ordinary farmyard manure.

This I trust effectually explodes and disposes of the fallacy to which I have referred, showing, as it does, not only that we can raise all the roots we may require, but that the *quantity produced per acre is thoroughly satisfactory*. Now let us turn to their *quality*. Turning to Table B (the reference numbers in which correspond to

* Tables A, B, C, and D were published as a Supplement to the paper and are not reproduced here. Readers who desire to possess all the details should apply for the *Journal of Society of Arts*, Vol. LII., No. 2,674, published by Geo. Bell & Son, Covent Garden, London; 6d.

those in Table A), showing the analysis of the beets grown, we learn from the grand total of the results a fact as surprising as it is gratifying, namely, *in every respect the quality of British-grown* sugar beetroots is *superior* to those grown in Germany, one of the greatest of sugar-producing countries. These results will be found summarised at the foot of the Table, and I must not omit to direct special attention to the figures in the first column, for two things might be passing through the mind of the observer, firstly that the British beet might be little and good, and secondly that even if during the tests they had not been pampered the results might be due to *virgin soil.* Happily the figures at once dispose of any such suggestion, the weight of the British roots being surprisingly greater than the German, getting indeed into the neighbourhood of double the weight. With regard to the effect of virgin soil, fortunately one is able to dispose at once of any such illusion; and it is a source of much gratification to me, upon such an important subject, to be able to impress upon you the important fact that the work of these pioneers—to whom I feel you will agree we owe much—have in many cases followed up the work year after year, and we have only to note the fact that the fine results to which I referred at first—those of Mr. Moens—were obtained from *land continuously under beet cultivation for a quarter of a century.* This authority informs me that he has grown the roots for over 30 years, principally for his cows, aad that the *crop has never once failed.* The summary referred to in Table B (Supplement) was that of the results of 42 tests in a single year. If, however, we look at Table VII. we find that the results are equally satisfactory when spread over a series of years.

TABLE VII.—ANALYSIS OF ROOTS.

Year.	Country.	Average Weight of Root with Leaves in Grammes.	Average Weight of Root without Leaves in Grammes.	Degrees Brix (Dry Matter).	Specific Gravity.	Quantity of Sugar in 100 Parts of the Juice.	Quantity of Non-Sugar in 100 Parts of the Juice.	Quotient of Purity.
1897	British	1,229	804	18·44	1·076	15·80	2·64	85·64
	German	1,148	561	17·81	1·074	15·07	2·74	84·05
1898	British	1,371	843	19·05	1·079	16·54	2·51	86·82
	German	974	539	19·02	1·079	16·32	2·70	85·80
1899	British	1,644	902	19·00	1·079	16·30	2·70	85·78
	German	957	611	18·30	1·076	15·45	2·85	84·42
1900	British	1,525	790	19·52	1·081	17·07	2·45	87·45
	German	1,064	557	20·00	1·083	17·38	2·62	86·90
1901	British	1,441	851	19·38	1·180	17·02	2·36	87·82
	German	1,112	621	17·66	1·073	14·76	2·90	83·53
1902	British	1,326	878	19·28	1·080	16·80	2·49	85·11
	German	1,042	492	17·43	1·072	14·79	2·64	82·74

I trust the figures shown and quoted will serve to prove, not only that the sugar-beet *can* be grown in England, but that when grown it is actually superior to the foreign-grown product, possessing as it does a higher percentage of saccharine—the entity for which it is grown. Furthermore, that it is superior in its quotient of purity and in the actual weight of the root, these valuable advantages being combined with the desired smaller percentage of "non-sugar." It will be observed that the average crop may well be taken to be 16 tons of roots per acre, and this again compares very favourably with the average crop obtained on the Continent. Even this in all probability, seeing that up to the present time there has been no call for the extensive cultivation of the sugar-beet in Great Britain, may be improved upon, and it may be interesting to mention that in Canada experiments have been recently carried out, with the result that an average crop of no less than 26 tons per acre has been obtained with seed sown early in May, and 23 tons with seed sown towards the end of May. Beet culture requires appropriate care, but presents no particular difficulty. Certain points should receive attention, and these are now known and understood; for example, in the Canadian tests just referred to it was found that if the root were covered with earth, so that none of it, save the leaves, was exposed, it made a considerable difference in the percentage of the sugar. In beet cultivation, as with every other form of agriculture, the enrichment of the soil should be apposite: thus, it is to be remembered that the amount of nitrogen influences the amount of crops per acre, phosphoric acid affects the quotient of purity, whilst potassium is in a certain ratio to the saccharine richness of the roots. As will be seen from the Table (VIII.) the leaves are largely responsible for the extraction and retention from the soil of the food substances, hence the sliced off heads may with advantage be returned to the land and ploughed in. Against this it has been usual upon the Continent to use these as foodstuffs for cattle, with considerable benefit, and to make up the loss by ploughing in the requisite extra amount of manure.

TABLE VIII., SHOWING FOOD SUBSTANCES EXTRACTED FROM THE SOIL BY 1,000 POUNDS OF BEET AND LEAVES RESPECTIVELY.

Food Substances.	Beets. Pounds.	Leaves. Pounds.
Nitrogen	1·5	4·0
Magnesia	0·7	2·6
Phosphoric Acid	1·0	1·5
Potassium	3·5	5·9
Lime	6·8	16·3
Totals	13·5	30·3

It now, I think, only remains for me to touch upon the interweaving of the work of the sugar factory with that of the agriculturist, and

to conclude by showing the practicability of introducing the vast industry into Great Britain, and to touch upon the enormous national benefit which could be made to accrue.

The interweaving of this industry with the agriculture to which I have referred is, of course, dependant upon whether the growing of beet will prove profitable to the farmer. Happily, again, the long series of tests prove this most satisfactorily and conclusively. The question is answered in a practical manner by the results obtained, not only in a single year, but by those obtained from cultivation year after year; and these not confined to one or two growers, but by a number of eminent agriculturists, and on land spread over a great area of our country—land extending hundreds of miles farther north than the latitude above which, we were gravely told, beet culture would be an impossibility.

The farmer, having hauled his crop of beets, cuts off their heads, thus securing the first bye-product, for these as already mentioned are good for feeding cattle. He then delivers his crop to the factory, where, during the process of manufacture, they are sliced into very fine slices. Of these the farmer subsequently receives back nearly a quarter—after the saccharine matter has been expressed—equivalent to some three tons for each acre's crop. This "pulp" is a most valuable feeding-stuff. In a subsequent process the saccharine liquor is treated with lime, and a residuum—called lime-cake, or saturated lime—is produced, and this the farmer also takes and uses as manure.

In the two following Tables, the first gives the cost per acre of sugar-beet growing, whilst in the second is seen the return from beet crops of 15 tons to the acre.

Cost of Growing Sugar-Beet per Acre.

	£	s.	d.
Rent and taxes	2	0	0
Clearing and forking weed stubble	0	1	0
Ten loads of farmyard manure	1	10	6
Carting 10 loads of fresh manure	0	5	6
Spreading manure	0	1	0
Ploughing 9 to 11 inches deep	1	0	0
Cultivating, including harrowing and rolling	0	6	6
Artificial manure	1	10	0
Sowing	0	2	6
Seed—30 pounds	0	12	0
Drilling	0	1	0
Hoeing and thinning	0	10	6
Harvesting	0	12	9
Carting to factory—15 tons, three miles, at 6d. per mile per ton, and 3d. per ton labour	1	6	3
	£9	19	6

Or say £10 per acre.

PROFIT AND LOSS ACCOUNT PER ACRE.

Dr.	£	s.	Cr.	£	s.
Cost per acre to plant, cultivate, harvest, and deliver roots	10	0	Receipts for roots, 15 tons, at 18s. per ton .	13	10
Profit per acre	6	10	Value 5 tons leaves and heads from roots ..	1	5
			Three tons slices, 20 per cent. of quantity delivered, at 10s.	1	10
			Value saturation lime ..	0	5
	£16	10		£16	10

The price here quoted—viz., 18s. per ton—is a fair average price for sugar beetroot. Now, at this figure, we see that from these alone the farmer makes £3 10s. per acre profit; but according to Mr. Stein, the value of the heads and leaves as feeding-stuffs is 25s., that of the slices, returned free from the factory, 30s., and that of the saturated lime for manure, 5s. It is unquestionable that these heads, as well as the thin slices of beet remaining after the sugar has been extracted, have great value as feeding-stuffs for cattle. This fact has been demonstrated, both experimentally and in actual farming, in every part of the Continent. It is a convenient food also, for the leaves may be compressed—with or without salt—and kept for many months as winter food, the slices also being obtainable from the factory during the winter months, when fodder is at its dearest. The feeding of cattle in combination with sugar-beet growing, it must be mentioned, gives the necessary amount of manure required for the crop. Moreover, the deep ploughing and careful culture, together with the necessity for proper manuring, required by the sugar-beet field, increase the cultivative value of the land for all succeeding crops. Although, for the sake of safety, the average crop has been taken in the Tables at only 15 tons per acre, there is little doubt that, with proper attention to such points as seed best suited to the district, the time of planting, and the hoeing processes, much better average crops can without difficulty be produced.

Thus it will be seen that there is an interweaving of the interests of cultivator and converter, of farmer and manufacturer, beneficial to each, and also to Garden Cities, if these be laid down upon scientific lines, as I venture to suggest should and indeed must be the case if these are to be anything more than philanthropically "bolstered" schemes of local land development. For the manufacturer requires much heat for boiling and evaporating: this the City would supply him in the form of cheap gas. But the farmer requires far more manure than the "lime-cake" affords; here again the City could supply his wants to mutual advantage in the form of sulphate of

ammonia, one of the bye-products in the manufacture of their non-illuminating fuel gas.

It is also to be assumed that Garden Cities will have their sewage farms, and these run upon the best and most modern principles. In this case, again, an interweaving could be effected, the requisite trials having already been carefully and exhaustively carried out by the city of Liverpool, under the able supervision of Mr. John A. Brodie, M.I.C.E., the city engineer. The results of some of this sewage-assisted cultivation are enabled, so to say, to speak for themselves by means of their photographs. Sewage disposal in inland towns is a problem increasingly absorbing the attention of engineers, and it is therefore most gratifying to find the highly satisfactory measure of success which has attended sugar-beet culture on sewage farms.

The results of beet culture by means of sewage at Liverpool are embodied in Table C (*see* Supplement). A noticeable feature of the Table is the enormous increase in the weight of the crop, whilst a gratifying feature is that, despite the great increase in weight of roots, the percentage of sugar yield should remain perfectly satisfactory. Sugar-beet has also been very successfully grown on other sewage farms, amongst them Oxford and Malvern. It has also been satisfactorily grown on other lands, using sewage as manure. The results of some of these experiments are given in Table D (*see* Supplement).

These Tables show there has been a steady increase in the size of the roots, and in the percentage of sugar in every 100 parts of the roots, from 1898 up to the present date. The Oxford sewage farm also produced in 1898 a series of really gigantic roots, which varied from 1,792 grammes to 2,941 grammes per root according to the variety used, "Klein Wanzleben" being the highest. The experiments made at the Grammar School, Shepton Mallet, in 1901 and 1902, are as interesting as they were successful. In the latter year no less than ten experimental plots were cultivated by Mr. W. Aldridge at this school, all under varying conditions of manure; the results being good, both as to weight of crop, weight of root, and sugar percentage. Were we to teach our rising generation the best way to raise this crop, and show them how profitable it can be made, we should make a vast stride towards regaining our old agricultural prosperity.

(To be continued.)

CONSULAR REPORTS.

Columbia.

The British Vice-Consul reports:—The sugar cane industry has been one of the most profitable in this country, especially since the outbreak of the revolution. As an example I will merely mention that molasses, which sold before the outbreak of the revolution for 10 pesos (8s.) a cargo, now fetches 1,000 pesos (£2). The following are the products of sugar cane plantations:—

1. *Miel.*—This is simply the raw juice of the sugar cane boiled to molasses. It is used in this state for making the national drink "chicha."

2. *Panela.*—This is made from miel, which is boiled and clarified by beating it in the pan and then placed in a pan to harden. It is very much used all through the country as an article of food for the poorer classes, especially in Antioquia, where it is almost the sole food of the peasantry.

3. *Sugar.*—This is also made from miel, in the most primitive manner. After the miel is boiled down to make panela it is clarified by means of lime, placed in mud moulds, and covered with mud and ashes until it becomes hard and gains a whitish colour.

Cane sugar imported from the United States cannot compete with the native article, but the German beet sugar has a good sale, as it can be sold here cheaper than Columbian sugar and has a better appearance.

Machinery for working sugar mills is made at the Pradera Iron-works, situated close to the capital. The iron is so inferior in quality that the mills are constantly breaking. The copper for pans is all imported from the United Kingdom.

Sugar mills are imported from the United States and the United Kingdom, but the greatest number come from the United States.

I know of one case of a planter who runs a coffee and sugar plantation together. He tells me that the sugar cane plantation pays the whole cost, not only of itself, but of the coffee, including its freight, commission, &c., to the United Kingdom and the United States. By this means the product of his coffee becomes a clear profit.

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. Thompson, C.E., F.C.S., M.I.M.E., Chartered Patent Agent, 6, Lord Street, Liverpool; and 322, High Holborn, London.

ENGLISH.—Application.

2928. L. Naudet, London. *Process of and apparatus for the diffusion and extraction of saccharine juice.* (Date applied for under Patents Act 1901, 6th February, 1903, being date of application in France.) (Complete specification.) 5th February, 1904.

ABRIDGMENT.

21200. M. Fontaine, Aix-la-Chapelle, Germany. *Improvements in sifting and straining apparatus particularly applicable to centrifugal separating machines.* 2nd October, 1903. This invention relates to an improvement in sieves for separating solids from solids or solids from liquids, such as ore, paper, wheat, sugar in which the effective sieve surface is composed of separate thin finely perforated plates, mounted on or in a frame plate provided with openings. Hitherto the frame plate of such sieves has been provided with smooth walled apertures of uniform size, extending through the entire thickness of the plate, over which apertures a plate provided with perforations of somewhat larger size was laid, which thus rested on the frame plate, and was fixed with its edges on the surface of the same, the perforated plates thus projected above the surface of the frame plate by the thickness of their plates.

GERMAN.—ABRIDGMENTS.

144787. Dr. Hermann Claassen, of Dormagen. *A method of regulating the supersaturation in boiling pure sugar syrups, more particularly thick juice.* April 17th, 1902. (Patent of Addition to Patent 117531, of February 12th, 1899.) The regulation of the supersaturation in boiling syrup is effected by the superconcentration (1·35 to 1·45, which has to be maintained for forming grain, in boiling pure sugar solutions or syrups, more particularly thick juice), being fixed according to a special water contents table for sugar syrups of high quotients of purity (91 to 93), whilst after the formation of grain, a diminished superconcentration (1·1 to 1·13) is set up, in order to avoïd the formation of fresh crystals, and then a systematic increase of the superconcentration, until the boiling down is completed (up to 1·3 to 1·35) takes place, which increase corresponds to the diminishing purity of the mother syrup.

146044. Heinrich Judenberg, of Brunswick. *Means for closing a diffusion vessel.* March 21st, 1903. The means for closing a diffusion vessel consists in the lid or cover and the lever pressing it tightly on, being arranged on a spindle common to both, and an operating crank connected with the pressure lever. The crank operating the pressure lever is connected with a means of applying pressure, such for instance as a spring, which is stretched by the lid pressed up by the contents of the vessel, and after the diffuser vessel has been discharged, presses its cover or lid automatically on to the opening in the diffuser.

146490. Schneider and Helmecke, of Magdeburg. *A means for automatically regulating the supply of heating steam in periodically working apparatus for heating liquids.* November 22nd, 1902. The spindle of the steam inlet valve is connected by means of lever mechanism with a float arranged in the evaporating pan, so that the

valve is adjusted to the actual level of the liquid. A lock coupling is inserted in the lever mechanism. The coupling is influenced by an electro magnet which is connected with a contact thermometer arranged in the evaporator in such a way that the steam inlet valve is automatically closed on the desired degree of temperature being reached.

146545. LUDWIG LORENZ, of Dormagen, near Cologne. *A double knife-box, for cutting beetroot shreddings, having a narrow front band-like toothed knife.* March 29th, 1901. The front knife is formed as a toothed knife. From the foot of each tooth there runs a supporting and stiffening bar downwards to the knife-carrier arranged beneath. The knife thus forms, in conjunction with its carriers, a full partition in the knife-box. Each separate shredding finds beneath the tooth which produces it, its separate annular passage and lateral guide. In order not to have to change the entire front knife if the knife-cutters work defectively, the front knife is composed of separate cutters bent out of a piece of strip steel, the said separate cutters being inserted in a slot in the knife carrying bar.

146871. Dr. OTTOMAR FRIEDRICH, of Brunswick. *A method of obtaining purer beet sugar juice.* January 9th, 1902. The object of this improved method is to obtain sugar juice or sugar beetroot and the like, in a purer condition than hitherto, thus obtaining an increased yield of sugar, and a large formation of crystals. It consists in adding in any suitable manner formaldehyde to the diffusion water or the raw syrup and shreddings contained in the diffusion or extraction vessels, and calculated according to the constitution of the roots, in quantities of from ·002% to ·0004% of juice, and ·0025% of fresh shreddings. This addition of formaldehyde, prevents albumen and other organic non-sugar substances, passing over from the shreddings into the juice.

IMPORTS AND EXPORTS OF SUGAR (UNITED KINGDOM,

To end of January, 1903 and 1904.

IMPORTS.

Raw Sugars.	Quantities.		Values.	
	1903.	1904.	1903.	1904.
	Cwts.	Cwts.	£	£
Germany	343,740	379,961	129,052	160,708
Holland	26,856	20,077	10,208	7,800
Belgium	130,674	19,751	53,820	7,516
France	3,852	6,154	1,926	3,201
Austria-Hungary	355,643	99,537	153,183	42,954
Java	....	34,779	....	17,300
Philippine Islands	....	....	....	....
Peru	20,541	90,006	7,400	40,950
Brazil	17,525	15,367	6,875	5,603
Argentine Republic	38,799	....	16,855	....
Mauritius	651	60,516	320	22,134
British East Indies	30,467	18,673	10,733	7,944
Br. W. Indies, Guiana, &c.	31,316	75,673	21,105	48,041
Other Countries	42,632	26,696	18,062	13,710
Total Raw Sugars	1,042,696	847,190	429,539	377,861
Refined Sugars.				
Germany	1,030,672	777,426	532,856	429,215
Holland	182,717	217,204	107,498	129,187
Belgium	7,970	31,075	4,611	17,323
France	57,692	100,551	32,876	55,218
Other Countries	135,501	64,768	69,016	33,365
Total Refined Sugars	1,414,552	1,191,024	746,857	664,308
Molasses	148,870	141,352	29,546	26,202
Total Imports	2,606,118	2,179,566	1,205,942	1,068,371

EXPORTS.

British Refined Sugars.	Cwts.	Cwts.	£	£
Sweden and Norway	1,625	517	862	385
Denmark	6,774	9,978	3,358	5,416
Holland	5,356	5,070	2,927	2,581
Belgium	1,108	1,209	520	695
Portugal, Azores, &c.	436	571	200	392
Italy	1,058	320	490	157
Other Countries	22,850	31,700	14,430	20,960
	39,207	49,365	22,787	30,586
Foreign & Colonial Sugars.				
Refined and Candy	1,667	1,563	1,177	1,179
Unrefined	3,148	3,588	1,633	1,946
Molasses	12	19	12	8
Total Exports	44,034	54,535	25,609	33,719

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1904. Tons.		1903. Tons.
Total Receipts, 1st Jan. to Feb. 18th ..	231,572	..	162,091
Receipts of Refined ,, ,, ,, ..	—	..	212
Deliveries ,, ,, ,, ..	221,424	..	159,094
Consumption (4 Ports, Exports deducted) since 1st January	186,475	..	162,585
Importers' Stocks (4 Ports) Feb. 17th ..	22,309	..	7,382
Total Stocks, Feb. 24th	106,000	..	153,009
Stocks in Cuba ,, ...	158,000	..	202,620
	1904.		1903.
Total Consumption for twelve months ..	2,549,643	..	2,566,108

CUBA.

STATEMENT OF EXPORTS AND STOCKS OF SUGAR, 1902 AND 1903.

(Tons of 2,240lbs.)	1903. Tons.		1904. Tons.
Exports	33,989	..	131,288
Stocks	137,651	.	115,125
	171,640	.	246,413
Local Consumption (one month)	3,700	.	3,850
	175,340		250,263
Stock on 1st January (old crop)	42,530	..	94,835
Receipts at Ports up to Jan. 31st ..	132,810	..	155,428

J. GUMA.—F. MEJER.

Havana, 31st January, 1904.

UNITED KINGDOM.

STATEMENT OF IMPORTS, EXPORTS, AND CONSUMPTION FOR ONE MONTH ENDING JANUARY 31ST.

SUGAR.	Imports. 1904. Tons.		1903. Tons.		1902. Tons.	Exports (Foreign). 1904. Tons.		1903. Tons.		1902. Tons.
Refined	59,601	..	70,728	..	180,202	78	..	83	.	103
Raw	57,569	..	52,135	..	96,820	179	..	158	..	321
Molasses	7,088	..	7,444	..	5,098	1	..	—	..	7
Total	124,258	..	130,307	..	282,120	258	..	241	..	431

HOME CONSUMPTION.

	1904. Tons.		1903. Tons.		1902. Tons.
Refined	63,400	....	64,276	....	185,592
Raw	10,987	....	41,459	....	113,563
Molasses	6,118	....	6,292	....	7,196
Total	80,505	....	112,027	....	306,351
Less Exports of British Refined	2,468	....	1,960	....	2,208
Net Home Consumption of Sugar	119,841	....	110,067	....	304,143

Stocks of Sugar in Europe at uneven dates, Feb. 1st to 24th, compared with previous Years.

In thousands of tons, to the nearest thousand.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	Total 1904.
96	1411	861	655	324	3348

	1903.	1902.	1901.	1900.
Totals	3165 ..	3375 ..	2664 ..	2562

Twelve Months' Consumption of Sugar in Europe for Three Years, ending January 31st, in thousands of tons.

(From Licht's Monthly Circular.)

Great Britain.	Germany	France.	Austria.	Holland, Belgium, &c.	Total 1903-4.	Total 1902-3.	Total. 1901-2.
1683	895	591	430	505	4104	3820	4195

Estimated Crop of Beetroot Sugar on the Continent of Europe for the current Campaign, compared with the actual crop of the three previous Campaigns.

(From Licht's Monthly Circular.)

	1903-1904. Tons.	1902-1903. Tons.	1901-1902. Tons.	1900-1901. Tons.
Germany	1,960,000 ..	1,762,461 ..	2,301,924 ..	1,984,186
Austria	1,190,000 ..	1,057,692 ..	1,302,038 ..	1,094,043
France	800,000 ..	833,210 ..	1,183,420 ..	1,170,332
Russia	1,200,000 ..	1,256,311 ..	1,098,983 ..	918,838
Belgium	225,000 ..	215,000 ..	334,960 ..	393,119
Holland	125,900 ..	102,411 ..	203,172 ..	178,081
Other Countries.	410,000 ..	325,082 ..	393,236 ..	367,919
	5,910,000	5,552,167	6,820,733	6,046,518

THE

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☞ The Editor is not responsible for statements or opinions contained in articles which are signed, or the source of which is named.

NOTES AND COMMENTS.

Messrs. Blyth Bros. & Co., Mauritius, report shipments of sugar from August 1st to February 17th, at 121,080 tons, as compared with 86,703 tons for the corresponding period of the previous season. It went chiefly to India and the Cape.

Exports from British Guiana from January 1st to 7th March, 1904:—sugar, 21,386 tons; rum, 765,461 gallons; molasses, 13 casks; molascuit, 996 tons; cocoa, 6,729 lbs.; against 25,799 tons, 848,527 gallons; 1,358 casks; 83 tons; and 14,430 lbs. respectively for the like period last year.

The Naudet Process for purifying Cane Juice.

On another page will be found a short description of the Naudet patent process for extracting and purifying cane juice. The Naudet process was originally applied to the treating of sugar beets; Mr. Naudet was, however, led to make experiments for its adoption for sugar cane. Some preliminary tests were made in Madeira, and these yielded results which fully convinced Mr. Naudet that the process as applied to cane sugar would be most valuable. Several improvements were then made, so that the working during last crop of this new process has given most satisfactory results. Now we hear that an order for a large "Patent Naudet Plant" to treat 600 tons of canes per day has been placed with Messrs. McOnie, Harvey & Co., Ltd., the well-known firm of Sugar Engineers in Glasgow, which is to be working in the West Indies within twelve months' time. We must therefore conclude that the difficulties originally encountered

have been sufficiently overcome to warrant the fitting up of a large establishment with the necessary apparatus for working the process.

We are informed that Messrs. McOnie, Harvey & Co., Ltd., of Glasgow, are the sole makers of this new patent machinery for the United Kingdom and the colonies.

The results claimed for this new process are so high, that we shall watch its evolution with interest.

Chambers of Commerce and the Sugar Tax.

When, now-a-days, any body of public men meets to discuss matters of general interest, the programme is apparently considered incomplete unless some reference is made (generally by interested parties) to the "evil effects" of the sugar tax on trade. At the recent meetings of the Associated Chambers of Commerce held in London, the Wakefield Chamber moved—"That this meeting is of opinion that, owing to the harmful effect the abolition of the sugar bounties has produced in the confectionery and allied trades, the time has come for the Government to seriously take into consideration the repeal of the sugar tax." This was supported by several representatives who were confectioners, and was opposed by the Bristol, Liverpool, and Greenock representatives. As far as the speakers were concerned, it was apparent that the wholesale consumers were in favour of the resolution, while the Chambers representing sugar producing centres opposed it. But while the wholesale confectioners are very much interested in the repeal of the tax, the sugar manufacturers and refiners have decidedly no interest one way or other. Previous to the coming into force of the Brussels Convention regulations, it was stated that the refiners reaped a slight advantage owing to the tax being levied on raws, but since last September all sugar has been refined in bond, and the tax is charged on the sugar passing out of the refinery. In effect, the refiner is simply the means of collecting the duty from the consumer. It is therefore evident that the refiners' representatives had more disinterested motives in opposing the repeal of the tax than had the wholesale consumers in calling for it. Amongs other things, the former deemed that, as is usually the case, cause and effect were muddled up in confusion in the resolution (what has the Brussels Convention got to do with the inland revenue tax of 4s. 2d. per cwt.?); that the falling off in consumption is due to other causes, *e.g.*, bad trade, especially in Lancashire; and, finally, that the resolution would have the effect of bullying the Government to repeal the tax, although they had stated they could not possibly undertake to do so. As to the vote on the resolution, it was lost by a large majority, showing that, outside certain interested quarters, there is a concensus of opinion that the sugar tax is a fair one, and tends to broaden the basis of taxation.

THE EARLY RESULTS OF THE BRUSSELS CONVENTION.

The negotiations which have at last resulted in the abolition of the sugar bounties were a long, tedious and vacillating process, full of stumbling blocks erected by party politicians or misguided economists, with much clamour of misrepresentation and erroneous reasoning. To abolish a bounty was "Protection;" to prevent the foreign producer from being protected in British markets was contrary to free trade; to countervail a bounty was a reversal of the commercial policy of the country. Such were the glaring fallacies that obstructed a purely free trade movement in its early days. Then came the monstrous doctrine that the consumer had a sacred right to be supplied with commodities below cost price; that unnatural cheapness was the corner stone of the free trade edifice; that the destruction of the natural sources of supply was one of the first principles of the science of political economy. It took more than thirty years to overcome these various blind prejudices, and even then they were not overcome but only over-ruled, by a masterful spirit and the force of circumstances. We arrived at a point where action must be taken at once if the industry of sugar production in our colonies was to be saved from absolute destruction. Bounties had so forced production that the world was flooded with a great deal more sugar than it could consume. Excessive stocks brought with them a fall in value far below the cost of production. Two years more of that state of things would have left us with the bounty-fed producer absolute master of the situation. It was manifest that no sane producer could continue to present the consumer with three pounds a ton out of his own pocket. Bnt even at that crisis the cry of the party politician was still to be heard, declaring that any attempt to secure for the consumer a permanent supply at its natural price—any effort to stay the inevitable destruction of all the natural sources of that supply—was a base and insidious blow at the first principles of free trade. It was gravely asserted by eminent statesmen that the consumer was about to be robbed of eight millions a year. It was useless to argue with such economic fallacies. Facts were rejected with scorn, while fiction was swallowed with avidity. Such was the position of the enlightened opposition when the Brussels Convention came into force last September.

The present condition of the sugar trade of the world is still to a considerable extent the old bounty-fed artificial state of things. The excessive stocks are still there, unsold, not yet wanted, and weighing on the market to such an extent that sugar is still to be had everywhere below cost price. Under such circumstances what do the misguided politicians say now? Where is their loss of eight millions a year? They are not ashamed, they make no apologies for their mistake, but cry, with as loud a voice as ever, a new cry,—that the price of sugar has been raised in this country and cheapened abroad.

This is the new fiction which they hope will be as greedily swallowed as the old one. Probably it will, though any one connected with the trade knows perfectly well the true answer. Sugar is still below cost price, but not so low as in 1901-02 simply because production was reduced after that season to the extent of 1,250,000 tons,—more than a year before the Convention came into force. It was the excessive stocks and the consequent excessively low price that caused this reduced production, which necessarily brought with it a certain amount of rise in price. A very small rise for such a large reduction in production, and a rise which turned out to be very premature. The consumer is still getting sugar below cost price, and yet the politicians try to represent him as paying through the nose for it. Some of them even try to mix up the small rise of 2s. per cwt. in value with the addition of the duty levied by Sir Michael Hicks Beach in 1901. Even that juggle is thought good enough dust to throw in the eyes of the public.

The fall in the price of sugar to the continental consumer, which is the other card they play, is simply a fall in the *duty-paid* price. Many countries, now that they have abolished the expensive policy of bounties, can afford to reduce their excise duty, and have done so in some cases on a very large scale. Other countries, which created cartel bounties by means of an enormous surtax on imported sugar, have been compelled to reduce that surtax to a very low figure. While the surtax lasted the price of sugar was raised by the cartel to the level, or nearly to the level, of the high protective import duty. That has been put a stop to, and the consumer gets his sugar at the world's price plus the excise duty. The opponents of the Convention seem to regard this as a terrible injustice. To promote the consumption of sugar throughout the world seems to them to be a deadly sin. They plunged years ago into the region of fallacy and they cannot get out of it. Each fallacy as it goes must be replaced by another, until confusion becomes worse confounded.

The confectioners as usual have their little grievance. They thought they ought to be supplied permanently with sugar at least three pounds per ton below cost price. They could not see that that was not only impossible but positively injurious to them, since it must result in their supplies of sugar being enormously curtailed and finally reduced to bounty-fed sugar alone, which might at any moment disappear, and which would in the meantime dictate its own price. Their contention that the abolition of the bounties would raise the price of sugar to the extent of eight millions must, therefore, have meant the average price. This little prophesy has not come off, and never will; but they did not dream that they would be even now enjoying sugar below cost price. This, however, does not satisfy them, and they are still full of complaints. An article below cost price is a fair object for taxation for revenue purposes, and yet they

clamour for the abolition of the very moderate duty. There must be a pretty good profit on the manufacture of sugar plums with the present low prices, but they want it to be made bigger for them. They also complain that they cannot send their sweets into foreign countries because of the import duty. But what was the import duty before the Convention reduced it? They do not tell us this.

Great pains was taken to secure, under the terms of the treaty, that no bounty should henceforth be allowed on confectionery. Great pains is still being taken to insure that the terms of the Convention are strictly carried out in that respect. And yet the confectioners grumble.

It is a cruel thing that our sugar producing colonies are still obliged to sell their sugar below cost price. Mauritius has even lost the equality of treatment it enjoyed in the Indian market when bounties were countervailed there. But these are temporary troubles, very serious no doubt, and which might have been averted if the prolongation of the bounty-fed glut of sugar had been foreseen. The remedy will come, and will come by a considerable reduction in the European production. When that reduction will be fully carried out it is somewhat difficult to predict. The continental producers are all preaching a great reduction in the sowings, but very few are ready to show a good example. Every big factory knows that it must work full or face a serious increase in the cost of production. Therefore, the big factories as a rule will not reduce their output. For the small factories the situation is sad and threatening. It is a case of the survival of the fittest, and they will be the first to go to the wall. The process began some years ago and will continue. It is painful to see those who were the pioneers of a great industry succumb before their more modern and more powerful competitors. It is the law of nature and will prevail.

The new preference to Cuban sugar in the United States is another disturbing factor in the situation. Such a preference has the effect of stimulating production in the country so favoured, and it will continue to do so until Cuba and her fellow favourites produce enough sugar to supply all the wants of the United States. Then the benefit will cease, because the duty on sugar in the United States will then cease to exist except upon paper. In the meantime our West Indian colonies practically lose their market in the States and will probably send the bulk of their crop to Canada and the United Kingdom. When prices have settled down on the sound basis of cost of production there is no doubt that cane sugar will have the best of the struggle and will come in an easy winner.

Up to now the effect of the Convention has been most apparent in the case of our home sugar refiners, who were the first to fight the bounties and are the first to reap the benefit of their abolition. The bounties have hit them, not by fits and starts as in the case of the

producers, but continuously. Their margin to pay cost of manufacture and profit is only about 2/- to 3/- per cwt. They do not care what the price of sugar is, but they must have a sufficient margin for a fair profit or to save them from absolute loss. By making better sugar than their continental competitors they have survived; but they have seen importations of foreign refined sugar increase during the bounty period from a merely nominal figure to a million tons per annum. That is the measure of what they have lost as far as expansion of their trade goes. Most of that foreign refined has been sold below the margin which would leave them without loss. If it were not so the sugar would not have come here. Threepence per cwt. is sufficient to convert a margin of 2/- from profit to loss. That threepence is all that the British consumer will lose by the abolition of bounties. The margin has now been restored to that extent and the refiners are no doubt thankful for small mercies. The imports of foreign refined will not immediately be largely reduced, because a long period of bounties has created a great industry on the other side of the channel, and we must wait till increased consumption on the continent absorbs the surplus before we can expect things to right themselves completely. The course of production and consumption during the next few years will be an interesting study, as of a patient recovering slowly and painfully from a serious and nearly fatal disease of thirty years' standing, which has only just been cured and requires a long period of recuperation before the patient can be declared well again.

SCIENCE IN SUGAR PRODUCTION.

By T. H. P. Heriot, F.C.S.

(Continued from page 110.)

II.—The Improved Raw Material.

(*a*.) Resulting from field culture.

The Science of Agriculture is the rational theory upon which the practical Art is based, and the sciences most directly connected with agriculture are the following: Chemistry, or the study of the composition and decomposition of substances; Biology, dealing with the phenomena of life: and Physics, which treats of the general properties of matter and of the causes which modify these properties.

Agriculture has made immense strides during the past century owing to the rapid development of these sciences. Old traditions have been examined; error sifted from truth; and the "why" and "wherefore" of every field operation made clear.

The illustrious Liebig was, perhaps, the first to solve agricultural problems in the laboratory and, since his day, many others have devoted their lives to extending his researches and have left to

posterity much valuable information concerning the chemical composition of plants and of the soils on which they grow. They have confirmed many facts which centuries of practical experience had laboriously collected and, by special methods of study, have arrived at more detailed information than could have ever been acquired outside the laboratory. Thus, for example, the ancients must have observed that crops exhaust the land, but it required chemical analysis to ascertain that certain elements of the soil, namely, Nitrogen, Phosphorus, and Potassium, are essential plant foods, and that the exhaustion of soil means a deficiency of one or more of these elements. Moreover, the soil may actually contain an abundance of these elements and yet prove unfertile because of unsuitable climatic conditions or the insoluble nature of the soil particles. The agriculturist is not concerned with the abundant supply of gaseous food in the atmosphere beyond ensuring that each plant shall have its due share; his attention is mainly directed to the limited stock of available mineral food in the soil, for lack of which his crops will fail.

The cultivated cane and sugar-beet are of greater agricultural value than the raw materials with which the two industries started. Generally speaking, a cultivated plant differs from the wild species in possessing greater vigour due to favourable conditions of growth, in other words, it is a finer specimen. But the valuable property of a plant may be improved at the expense of other characters, resulting in the production of a distinct, and even abnormal, variety. Improved varieties are "created" by two methods of culture:—

(*a*) Modified conditions of growth or field-culture, and

(*b*) The valued character is inherited from a selected pedigree. Only the former method will be considered in this paper.

The Beet.

The forage-beet, as a sugar producer, was of little value for two reasons: its low saccharine richness and the difficulties experiencd in crystallising the sugar from the expressed juice. Cane juice, under precisely similar treatment, yields an abundance of sugar crystals whereas the forage-beet syrup remains limpid or yields but a few microscopic crystals after long cooling. Achard and other chemists set to work to discover the cause of this anomaly and found that the beet juice contained certain salts in solution in addition to the sugar. On analysing the juices extracted from different varieties of root they further ascertained that, in proportion as the saline impurities decreased, the more readily did the sugar crystallise from the syrup.

For the promotion of a beet sugar industry, it was therefore essential to find a variety of root containing less saline impurities. This problem attracted the combined scientific genius of France and Germany. Chemists dissected the plant; they analysed the foliage, the root, the soil, and the atmosphere, establishing the fact, previously stated,

that sugar is formed in the leaf and is composed of elements derived solely from the atmosphere, whereas the office of the rest is to supply water and saline nourishment.

The problem was thus reduced to a case of "leaves versus roots," in other words, the surface-ratio of leaves to roots determines the proportion of sugar to salts in the sap of the plant. The undesirable saline food being absorbed by the fine root-hairs which extend in all directions through the soil, it was only necessary to reduce the area of soil occupied by each plant in order to limit the available supply of salts.

Vilmorin solved the problem by causing a great number of roots to grow on a given area, with the result that each root was dwarfed, but contained a minimum of saline matter dissolved from the soil. Above ground each plant was allowed sufficient space to spread its foliage, and to manufacture sugar from the abundant supplies of gaseous elements in the air; consequently the sugar produced by a normal growth of foliage was stored in a smaller root. The forage-beet, when rasped and pressed, yielded a juice containing about 5% of sugar and from 1% to 2% of salts. With the same treatment, the improved beet yielded juice containing from 15% to 18% of sugar, with from 0·3% to 0·4% of saline impurities. Two obvious advantages were gained by this system of close planting. The manufacturer obtained a sweeter and purer juice, from which sugar readily crystallised in a marketable form. The farmer grew two or more roots where one grew before; the reduction in the size of the roots being compensated for by their numerical increase. His crops removed less mineral matter from the soil, so that his fields required fewer applications of expensive manures. Vilmorin, pursuing his researches, created a beet containing 20% of sugar, and giving an improved yield of sugar per acre, although the weight of roots was reduced to one-third of that of the forage-beet crop. But at this point the beet industry became "a house divided against itself," for, although an ideal raw material was realised by the manufacturer, the farmer could no longer make ends meet when paid on the weight of his crop. This difficulty was avoided, to a certain extent, by the manufacturer paying better prices for sweeter roots, as ascertained by the density of the expressed juice, but, fiscal conditions interfering, further improvement of the beet had to be abandoned, or was limited to the cultivation of the extra-rich beet on lands owned directly by the factories. Science, headed by Vilmorin, was then called upon to satisfy both parties, and succeeded in creating other varieties, including the "Conciliation" beet, combining fair saccharine richness with weight of roots per acre.

Another difference between the forage and sugar beet is the habit of growth. The root of the former is but slightly embedded in the ground, about half its length being exposed above the surface. The

root of the sugar beet, on the contrary, develops entirely below ground, and the richness of the contained juice is dependent on this character.

The adoption of a purchase system based on the richness of the roots not only compensates the farmer for the reduced weight of his crop, but also secures his assistance and interest in improving the root from the manufacturer's point of view. An example* will make this clear :—

"A field cultivated by scientific methods will furnish 25,000 kilos of roots per hectare (=10 tons per acre), yielding juice of 5·75° density (sp. gr.=1·0575). The manufacturer pays for these roots at 20f. per 1,000 kilos with juice of 5·0° density, and an increase of 1f. for every ¼°. The roots therefore fetch 23f. per 1,000 kilos, or a total of 575f.

"A field of the same size, cultivated by old methods, supplies over 20,000 kilos per hectare (=8 tons per acre), yielding juice of 4·5° density. The manufacturer paid 18f. per 1,000 kilos of roots, regardless of their richness, so that the 20,000 cost him only 360f., which is a great deficit for the farmer. Which of the two roots is most profitable for the manufacturer—those at 23f., or those at 18f.? It is known that a difference of 1° density corresponds to a difference of 2 % in the yield of sugar on the roots. From the roots, with juice of 5·75°, there are obtained 25 kilos per 1,000 more sugar than those with juice of 4·5°.

"Therefore, in paying 5f. more, the manufacturer gains 15f., the difference of 10f. being clear profit; whilst the farmer gains 215f. on the produce of his field."

Sugar being the material bought by the factory, field operations had to be adapted to the special requirements of the new crop. Practical trial taught the farmer that surface tillage would not allow the long tapering roots to penetrate to a sufficient depth in the soil. Ploughing to the depth of from 10 to 12 inches was found to be necessary, and this deep cultivation so increased the natural fertility of the land for other crops, grown in rotation, that the introduction of the sugar beet may be said to have revolutionized Continental methods of agriculture.

Flat-cultivation of the root is general in France, but the well known method of ridge-cultivation has given remarkable results both in richness and yield per acre, owing to the greater depth and more perfect aeration of the soil surrounding the roots, the facility of weeding, and the more perfect admixture of the manures ploughed in. the ridges are spaced 2½ feet apart, the distance between the roots being about 4½ inches, and giving about 4,500 roots to the acre. Experiments on this method of culture, by M. Champonnois, gave the following results with the different grades of beets :

* Horsin-Deon "Traite theorique et pratique de la fabrication du sucre."

Weight of roots tons per acre.	Per cent. of sugar in roots.	Quotient of purity of juice.
39·8	6·9	66·7
36·0	13·5	83·0
26·7	14·9	83·9

Flat-cultivation in France gives a maximum yield of about 16 tons of roots per acre, with juice containing from 14 to 16 % of sugar. These results also illustrate the remarkable difference between a crop of forage roots and of sugar beets. The former continue to vegetate until the harvest, and the increase in bulk of the root is partly due to the assimilation of the stored sugar and its conversion into cellular tissue. Such a condition of growth is fatal to the crop of sugar beets, for in this case an early maturity of the roots is essential in order that the sugar, elaborated by the foliage during the latter part of the summer, may be stored in the root, without being required to nourish a later growth. Special atttention has been given to the selection of manures, and to the proper times for application to meet these requirements.

A maximum crop of 16 tons of topped roots will remove from an acre of land the following approximate proportions of the three essential plant-foods:—

	Lbs. per acre.
Nitrogen	70
Potash	154
Phosphoric acid	30

Nitrogen is essential for the vegetative growth of the plant, and therefore determines the weight of the crop.

Potash is also indispensable to the growth of the root, and, to a certain extent, increases the yield of sugar, but any excess only adds saline impurities to the juice.

Phosphoric acid increases the saccharine richness and purity of the juice.

The manuring of the sugar beet has long been brought to a high degree of efficiency by methods of field-experiment first devised by Ville.

A complete manure, containing all the plant-foods in suitable proportions, is applied in the following manner to land intended for beet culture. A portion of the field is divided into seven small plots; the first receives the complete manure, five plots receive the mixture but with one or other essential ingredient omitted, and the last plot has no manure added. All the plots are otherwise treated alike and sown with the same seed. The farmer can then watch the progress of the experiment and, when the roots reach maturity, each plot is separately harvested, the roots weighed and submitted to analysis. This method gives more reliable information than can be obtained by directly analysing the soil, and has the advantage of teaching the farmer to experiment and observe for himself.

Soil-analysis may indicate a deficiency of one or more elements required by the crop, but these elements cannot be applied in the pure state. Let us suppose that a certain soil is proved to be deficient in nitrogen. This important and expensive plant-food is a gaseous constituent of the air, and therefore freely penetrates arable soil to a great depth. But in this elementary form nitrogen cannot be directly absorbed by plants, so that the fertility of the soil can only be improved by the addition of some compound of nitrogen. We have then to choose from a variety of well known fertilizers, which may be broadly divided into those containing organic nitrogen which is very slowly available to plant-life because the material must first decompose in the soil:—farm-yard manure, hoof-meal, dried-blood, guano, &c., and those soluble forms of nitrogen which are immediately assimilated, such as sulphate of ammonia and nitrate of soda.

Soil analysis cannot indicate which of these forms will be most effective for any given crop, hence the absolute necessity for methodical experiment in the field.

We may here conclude the present section on the improved beet by summing up the knowledge gained by scientific methods of field culture.

1. The ultimate object for which the sugar beet is grown must control every operation in the field.

2. The improved beet is a very inferior vegetable to the original forage plant if judged by size of roots and weight of crop, but from the more practical view it is vastly superior as a sugar crop.

3. Soil intended for beet culture must be carefully selected: it must neither contain an appreciable quantity of soluble salts, which are so objectionable to the manufacturer, nor any excess of decomposing animal or vegetable matter, which would increase the weight of the crop at the expense of the sugar; the land must be naturally or artificially drained, and in every way suitable for deep cultivation.

4. Excessive manuring is injurious to the production of a good sugar crop, hence the cultivator must know—

(a.) What plant foods, and how much of each, the beet crop will remove from his land.

(b.) What elements are deficient in the soil.

(c.) What commercial fertilizers will contain the needed elements and in what proportions they should be added to give the best returns in yield of sugar.

(d.) The time to add the different fertilizers so that the young plant may early develop foliage for the production of sugar, and the roots mature at the proper season.

Ignorance on the part of the cultivator means serious loss.

THE CANE.

From our second remark in the foregoing summary on the field-culture of the beet it will be obvious that the improved cane must furnish a higher yield of sugar per acre than the normal yield of any existing variety.

In the good old days, a small sugar estate realised enormous profits. With slave labour and an increasing demand for sugar in a world-wide market, the early planters were not troubled with statistics showing yields and percentages, and it required a formidable competitor to convince them of the value of science in the field and factory. It is not, therefore, surprising that scientific culture of the cane has followed the lead of the beet.

The composition of the cane was first published in 1883, and experiments to determine the relative yields of various known varieties were commenced in 1888. Attempts to improve the cane have been made by both the methods referred to at the beginning of this paper. Limiting the present enquiry to the methods of field-culture, we may first observe that the richness and purity of the juice of the cane have not been increased by such abnormal field conditions as have evolved the sugar beet from the inferior forage plant. The sugar cane of to-day is a normal plant differing from the wild type in possessing greater vegetative vigour.

A crop of 30 tons of cane remove from an acre of soil the following approximate proportion of plant-foods:—

	Lbs. per acre.
Nitrogen..	30
Potash..	75
Phosphoric acid	20

Comparing these figures with those given for the beet, it will be seen that a double tonnage of cane removes only about one-half the quantity of plant-foods required by the beet.

For the past 20 years scientific experts have been studying the manurial requirements of the cane, and the general conclusions arrived at by Prof. Harrison's experiments at the Botanic Gardens of British Guiana may here be reproduced:—

1. The yield of canes per acre is governed by the amount of readily available nitrogen either naturally present in the soil or added in the manure applied.

2. When applied in quantities containing not more than from 40 to 50 lbs. of nitrogen per acre, sulphate of ammonia and nitrate of soda are, on the majority of soils, equally effective as sources of nitrogen, but when the unit of nitrogen in these substances is of equal value, it is, as a rule, more economical to apply the former rather than the latter. Dried blood and similar organic manures in which the nitrogen only slowly becomes available are of distinctly lower value as sources of nitrogen than the two above mentioned.

3. Under ordinary conditions of soil and climate, and the usual range of prices for sugar, it is not advisable to use more than 2 cwts. of sulphate of ammonia, or its equivalent, $2\frac{3}{4}$ cwts. of nitrate of soda per acre.

4. If circumstances arise which render it desirable to obtain the maximum yield per acre by addition of nitrogen in quantities in excess of about 50 lbs. per acre, sulphate of ammonia ought always to be selected as the source of nitrogen.

5. Practically on all soils manurings with nitrogen require to be supplemented by applications of phosphoric acid. The most effective forms of phosphoric acid appear to be superphosphate of lime and slag phosphate meal. Mineral phosphates are of distinctly lower value, and are not effective unless applied in quantities far in excess in value of those required of either superphosphate or slag phosphate. As a rule the phosphates should be applied only to plant canes, their manurial action on ratoon canes being but limited.

6. On some soils the application of potash salts in quantities of from 60 to 160 lbs. of sulphate of potash per acre results in greatly increasing the effectiveness of the nitrogenous manurings ; while on many others these applications have but little effect.

These conclusions are supported by Scard's experiments on the estates of The Colonial Company in the early eighties. Both experts are of opinion that the saccharine richness of the cane is not influenced by manuring and, consequently, that higher yields of sugar from existing varieties of cane can only be looked for in increased weight of canes per acre.

(To be continued.)

THE NAUDET PATENT PROCESS FOR EXTRACTING AND PURIFYING CANE JUICE.

By Robert Harvey, M.I.M.E., Sugar Engineer,
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This process, as applied to the cane, is designed to treat single-crushed megass, which, after extraction in the battery, is recrushed by a second mill for final use as fuel.

The process is essentially a systematic washing, or maceration, of megass in a battery of eight or more cells, in combination with the filtration of the total output of juice. A centrifugal pump, exterior to the battery, constitutes an apparatus for forced filtration, and includes—

Two pipe mains, with suction and delivery valve connections to each cell.

Two straining boxes, for separating cush-cush.

A compensating tank for equalising the pressure in the cell.

Two juice heaters, worked alternately.

Filtration of Limed Mill Juice.

Each cell, in turn, is filled with fresh megass from the cane mill, whilst the equivalent yield of mill juice is being limed and heated. The hot juice, with the suspended impurities, is then added to the cell, and the latter connected to the pump. Filtration is complete in from three to five minutes, when the bulk of the mill juice can pass at once to the evaporator. This filtration is effected by drawing juice from the bottom of a cell, pumping it through a heater, and returning it to the top of the same cell. The motion of the circulated juice is, therefore, downward through the cell of megass and upward through the exterior part of the circuit.

In the meantime, the next cell of the battery has been filled with megass, and another portion of juice limed and heated. The pump-circuit is therefore shunted to this cell, and filtration effected as before. These operations are repeated round the battery, so that the entire output of the cane mill passes into the battery. The Naudet cells form a battery of megass filters, each of which is in operation for about five minutes, so that the filtering medium is always fresh.

Megass Maceration.

In the preceding process of filtration, the two products of the cane mill are reunited in the cells of the battery, and, after the filtered juice is withdrawn from any one cell, the residual megass remains saturated with this juice. The recovery of this "free" juice by systematic maceration immediately follows, whereby the sugar normally present in the original megass is likewise extracted. The eight cells form a circuit, the bottom of each cell communicating with the top of the next. The liquid contents of the cells can therefore be displaced from cell to cell round the battery, whilst the megass remains stationary in each cell. This displacement is effected by introducing water under pressure, and subsequently compressed air to one cell at a time. The saturated (sweet) megass, from which filtered juice has been withdrawn, is successively immersed in seven distinct liquids (*i.e.*, mixtures of juice and water) of diminishing densities, and finally receives fresh water to remove the last trace of sugar. This final wash-water is then displaced, or driven forward, by compressed air into the next cell, and the exhausted megass is discharged from the bottom of the cell and delivered to the re-crushing mill.

The new process dispenses with all existing methods of treating the juice between the mill and the evaporator.

The entire output of juice is filtered, and that of the megass is macerated. The Naudet apparatus does not occupy much space, and the operations, when once clearly understood, are simple and clean. Being essentially a scientific method, its successful application can only be ensured in factories where chemical control is adopted.

Being also a continuous treatment, day and night work is absolutely essential.

The adoption of this process would relieve existing mills of all excessive strain, as it is quite unnecessary to exceed 65 per cent. extraction of juice by the mill. A powerful second mill is, however, required for re-crushing the wet exhausted megass when discharged from the battery.

The result of analyses of the final megass and waste-waters indicate that the loss of sugar by this new method of extraction is less than one per cent. on weight of cane, and that the dilution of the normal juice is about half of that required by the usual method of maceration by spraying the megass with water between the mills.

SUGAR INDUSTRIES OF HAWAII AND TRINIDAD.

In the course of a visit to Hawaii, recently, Mr. W. G. Kay, of Trinidad, was interviewed by a local paper which afterwards reproduced the conversation. It chiefly dealt with a comparison between the sugar industries of Hawaii and Trinidad:—

"I came here primarily to study steam cultivation and to look into the methods of production in Hawaii," said Mr. Kay. "Your own country has a world wide reputation as being foremost in methods of sugar production, you know.

"We tried steam plows in Trinidad about 20 or 25 years ago, and they were not a success. The plows used were crude, and there has been great progress since. So I came down to study their use. Mr. Fowler, who visited Trinidad some time ago, gave me letters of introduction to some of your planters.

"Conditions are widely different in Trinidad and Hawaii. There is a difference in the condition of soil and in the rainfall. In Trinidad our average production is two tons of sugar per acre—here you have double that amount. Porto Rico, Demerara, and Cuba are much above the two ton average. Porto Rico figures on about the same production as you do here, and they average four tons to the acre.

"Our soil is very different from that you have to do with here. A large portion of the sugar land in Trinidad is flat or bottom lands, which are difficult to drain. We have no irrigation or pumping machinery, and depend entirely upon the rainfall. Our average annual rainfall is 80 inches. We have a wet season and a dry season; the three months of the dry season are utilized for grinding our cane. Without the dry weather we would have a hard time cutting cane, because of the water on the bottom lands. It is generally dry a portion of January, February, March, and a part of April. The wet season breaks early in May. The grinding has to be done in the

early part of the year. We generally plant in October and November and the early part of the dry season, and reap the crop the following year, giving it from 14 to 15 months to mature.

"The total sugar output of Trinidad is about 60,000 tons yearly. It used to be larger, but has dropped. That was in the day of the smaller plantations, from 400 acres and up. They could not be run on a paying basis though, and now we have large estates. Some of them are as large as those on Hawaii, although as a rule they are smaller.

"Cocoa and asphalt are exported as well as sugar, these three being our principal exports. Lately, too, we have been boring for oil in the asphalt district, and some oil has been found, but not in flowing quantities. We could use oil very well as fuel, as coal costs considerable with the duty, and there is also a heavy duty on oil. The plantations could make good use of oil as fuel, as is being done here now.

"Sugar costs us from $45 to $48 to produce—the average cost here, I am told, is from $40 to $45 per ton. It is almost impossible to say what sugar nets us. Last year during the depression due to the bounty-fed beet sugar, we had to meet the competition and sell our sugar at cost price at the estate. The planters have been hanging on now for some years; some of them at a loss, waiting for the bounty system to end, for naturally with no prospect of the continental bounty being abolished, capital was loath to invest in our main industry. In Hawaii you have the benefit of the protection given by the United States.

"Our fields are worked almost entirely by negro and East Indian labour. Our negroes I consider to be much superior to the Southern negro of the United States. Unskilled field labour in Trinidad costs from 40 to 70 cents a day, although it is hard to strike an average, because we have so little day labour, doing our work almost entirely by the piece. Our field labour costs from 40 to 45 cents a day. Our indentured East Indian immigrants cost about 25 cents a day, and the cost of keep runs the expense to 40 cents. The Government brings in the immigrants, and we pay two-thirds of the expense through an export duty on sugar. The other third comes out of the general revenue. The term of indenture is five years, after which the East Indians are allowed to do as they please. About one-fourth of them go back yearly. We get four or five shiploads annually, each trip bringing 600 or 700 labourers. About one-third of the immigrants brought in are women. Generally the East Indian remains with us and engages in farming, many of them going in also for shopkeeping and other pursuits. There are no skilled artisans among them, that class coming from the negroes. The East Indian becomes a good citizen.

"Our fields are planted in 20 or 25 foot beds, with drainage canals down each side. We have no pests to contend with of any moment although the borer does some damage. Our chief danger is to the young cane from droughts or floods.

"I spent a fortnight along the Hilo and Hamakua coasts since coming here," continued Mr. Kay, "and visited many of the plantations along the way. This week I visited Honolulu plantation, and after seeing a few more of the Oahu estates will go to Kauai. From my observations so far, I believe the Hawaiian planters go in for more intense cultivation; they cultivate far more than we do; that is probably because the soil is more fertile. I drove through the Hamakua district from Hilo to Waimea. The most prominent impression one gets is the yield—the large amount of cane standing. Many of the estates are broken up by ravines and gulches, and I think are more difficult to work than our plantations. In Hilo the grinding plants are superior, although I did not like the arrangement of the mills. The Honolulu mill is splendid, though. I like the arrangement of it immensely, especially the labour-saving devices and the arrangement of the interior, requiring a minimum of supervision.

"In the West Indies triple crushing is the exception, while here I find it to be the rule. In Trinidad the double rollers are used almost entirely. Your plantations are larger also in acreage, and tremendously larger in output. I was impressed with the purity of the juice in the Hilo and Hamakua districts. I was struck also with the great kindness and courtesy shown everywhere, and I certainly appreciate it."—(*Sugar Planter.*)

THE SUGAR INDUSTRY IN EGYPT.

For some time past the attention of the sugar world has been repeatedly drawn to the latest evolution of the sugar industry in Egypt. It therefore seems worth while giving the substance of the latest information as to the present condition of affairs.

The year 1903 marked an epoch in the development of the sugar industry in Egypt; in so far that the nine sugar factories of the Daira Sanieh worked for the last time under State control, and at the end of the same year the total production of Egyptian sugar, which has varied during the last few seasons at between 90,000 and 100,000 tons, had with the exception of that from a few small private factories of no importance, fallen into the hands of the Société Générale des Sucreries et de la Raffinerie d'Egypte.

In a preceding account it was stated that the Daira had decided to sell its nine factories to a Syndicate formed for this object, and that

the latter would undertake the disposal of them to the Société Générale. Since then the transactions have been carried out. In November, 1902, the Daira sold its nine factories and their stock, consisting of 520 kilometres of railway, 55 locomotives, and 2,100 wagons to the Daira Sugar Corporation Ltd. The sale price was £944,800 sterling, being £171,800 cash and £773,000 in securities at 4%.

The transfer was first fixed for October, 1905, but the date was subsequently altered to April, 1903, under payment of a net sum of £850,000 sterling. The Société Générale on its part has contracted with the Daira Sugar Corporation to run the usines for a period of 25 years under payment of 24 annuities of £112,000 sterling each. At the end of 25 years the Sociéte Générale will become sole proprietors of the objects of the sale. The transfer of the factories was to have been carried out on April 1st, 1903.

The Société Générale does not at present intend to work more than six of its newly acquired factories, but will considerably enlarge these six. It will be possible to treat 12,000 tons of canes per diem, and, in order to undertake fresh expenses, the Company has increased its capital by some 44 million francs. It calculates that the cane needed for this increased production will be easily obtained, thanks to the new barrage at Assuan which will permit cane cultivation on vast tracts of hitherto sterile lands in Upper and Middle Egypt. The conditions existing hitherto, when cane has often failed for want of proper irrigation, are no longer expected to occur, and it is possible that the next crop may see a remarkable increase all round.

In the last campaign (1902-03), which extended from the middle of December to the beginning of April, eight out of the nine Daira factories were at work, but the campaign was very short for some of them. The minimum was 52 days and the maximum 93, the mean 76 days; 501,682 tons of cane were worked up, producing 46,264 metric tons of No. 1 sugar. This was the lowest figure of production at Daira since 1892.

The yield in 1st jet sugar was in 1903 9·22 % of cane, as compared with 10·01 % and 9·81 % respectively in the two preceding years. The 1903 cane was therefore relatively poor in sugar; this was accounted for by the unfavourable climatic conditions which prevailed in that season.

The second and third sugars are only found to a limited extent in the Daira production. In 1902, 52,697 cantars of 2nd and 20,171 cantars of 3rd sugar were produced, as well as 257,182 cantars of molasses.*

For alcohol manufacture only a portion of the molasses was used, amounting to about 126,000 cantars in 1902. According to the annual official report of Daira the molasses realized in 1901 3 piastres

* 1 cantar = 45 kg.

per cantar and the alcohol 1 piastre 17·6 para per oka of 1·24 kg. The advantage of distilling the molasses, as compared with selling it, is therefore doubtful.

The total production of sugar during the campaign of 1902-03 seems to have attained to 50,000 tons. This was a decrease of 10,000 tons on the preceding campaign. The production of the Société Générale, whose three usines had a capacity of 5,500 tons of cane per diem, has not yet been published—being kept back for the annual report. In the last report for the period between November 1st, 1901, and October 31st, 1902, some 352,512 sacks (of 100 kg.) of sugar were obtained, against 305,473 in the preceding campaign. The excess of 47,039 sacks was less than anticipated, owing to an insufficient rise in the Nile. Ten years ago the Société's production was only 41,000 sacks.

Several repeated attempts at beet growing only ended unsatisfactorily, and in some quarters it is said that all further trials in that direction are abandoned. The *Journal d. F. de S.*, however, thinks this is not accurate, and says the sowings have only been temporarily reduced, as a series of bad Niles has resulted in a plague of insects very destructive to the beet. But with a favourable rise of the river once more there is no longer any reason for not continuing the experimental beet culture.

The British Company, founded in 1896, the "Egyptian Sugar and Land Company" lent its Baliana factory, with all its appurtenances, to the Société Générale in 1901 for a period of five years, renewable at the option of the latter company for a further five years. This factory has been inactive during the last two campaigns.

In the meanwhile the Sugar and Land Company seems resolved to go into voluntary liquidation. Consequently it no longer counts in the sugar industry. Of the several other private factories existing in Egypt only one was in work during 1903, this being the one belonging to the Executors of Sultan Pasha at Damaris, near Minieh. Its campaign lasted 79 days, ending 8th March. In that time 563,931 cantars of cane were treated, and 46,892 cantars of sugar obtained, being a little over 8·3 % of cane.

In all the production of sugar in Egypt in 1902-03 should have been about 87,500 tons, supposing the production of the Société Générale was equal to that of the previous year. In that case it was 10,000 tons less than the previous campaign.

In order to appreciate the situation in the Egyptian sugar market, it is worth while giving the figures appearing in the last report of the Société Générale touching the refinery output. Their refinery sold in the 1901-02 campaign 38,091 tons of sugar as compared with 33,873 tons in 1900-01, and 30,034 tons in 1899-00.

Of these increasing amounts, the largest part has been taken up by local consumption, being 31,023 tons in 1901-02, and 27,657 tons in

the preceding campaign. Exports have shown but a small increase in that period, 7,068 tons against 6,217 tons. But in spite of the increased sales of refined sugar in the home market, the imports of similar foreign sugar have shown appreciable progress. They have been according to the Customs:—

Year.	Tons.
1902	10,362
1901	7,424
1900	6,041
1899	2,738

These figures point to a very rapid development in the Egyptian sugar consumption, and enable one to appreciate the extent to which it is capable of yet attaining. From what has been said, Egypt should actually have a consumption of about 41,000 tons. For ten million inhabitants, this is about 4 kg. per head per annum. On this basis about a quarter is furnished by the importation of foreign sugar. The foreign import consists chiefly of Austrian and Russian sugar, and in 1902 Austria was responsible for 80 % of the total.

The price of sugar on the local market at Alexandria has been of late for native sugars from 40 to 60 piastres per cantar of 45 kg. (10 fr. to 11·25 fr.).

The exportation of raw sugar has decreased in the last few years, owing to the increasing requirements of the Hawamdieh refinery, the only establishment of its kind existing in Egypt. In 1900 it exported 49,488 tons of refined and 4,292 tons of raw. In 1902 the figures were 41,242 tons and 3,417 tons respectively. The principal customers have been America, Turkey, the Red Sea, and the Persian Gulf.—(Abridged from the *Journal de F. de S.*)

PROVISIONAL METHODS OF THE HAWAIIAN SUGAR CHEMISTS' ASSOCIATION,

Adopted October, 1903.

The methods of analysis adopted as provisional at the annual meeting of the Hawaiian Sugar Chemists' Association, October 26th and 27th, 1903, as well as general recommendations approved, were placed in the hands of the Executive Committee for compilation and editing, and as a result of this work the Executive Committee submits the following, feeling sure that the methods, while in no way perfect, are a distinct advance over those proposed before.

Basis of Calculation.

The amount of sucrose coming to the mill in the cane is to be used as the basis of calculation, and this amount is found from the weight

of the cane and the per cent. sucrose in the cane calculated by the following formula:

$$\% \text{ Sucrose in cane} = \frac{\% \text{ Sucrose normal juice } (100-\text{F.})}{100}$$

where F is the fibre in the cane.

Normal Juice.

Normal juice is the actual cane juice, and its composition is to be found as follows:—

Density. The density of the normal juice is found by averaging the density of the juices from the different sets of rollers when no water is used for maceration. Such a test should be made once a week, and the factor

$$\frac{\text{Density mixed juice} \times 100}{\text{Density first juice}}$$

used for daily calculation.

Purity. The purity of the normal juice is found by averaging the purity of the mixed juice with that of the residual juice in the bagasse. The purity of the residual juice should be determined in one sample of bagasse each day, as directed under bagasse. The purity of the normal juice is expressed:

$$\frac{\text{Extr.} \times \text{Purity mixed juice} + (100-\text{Extr.}) \text{ Purity residual juice.}}{100}$$

Sucrose. The sucrose in the normal juice is expressed:

$$\frac{\text{Brix. normal juice} \times \text{Purity normal juice}}{100}$$

An example of these calculations may be taken as follows: Extraction assumed, 94·5. Purity of mixed juice, 86. Purity of residual juice, 59. Density of first juice, 18. Density of mixed juice, without maceration, found to be 99·8% of density of first juice.

From these figures we find density of normal juice =

$$\frac{18 \times 99{\cdot}2}{100} = 17{\cdot}86$$

Purity of normal juice is found to be

$\frac{94{\cdot}5 \times 86 + 5{\cdot}5 \times 59}{100} = 84{\cdot}5$; and from these the sucrose in the normal juice is found to be $\frac{84{\cdot}5 \times 17{\cdot}86}{100} = 15{\cdot}09$

It will be noted that an assumed extraction enters into these calculations; but it will be found by making the calculations, using different assumed extractions, that the difference in the final result is insignificant, no matter what the extraction is assumed within the limits of ordinary work.

Cane.

Fibre only is to be determined in the cane, and samples should be taken at least twice a week.

Samples should be taken by cutting equal lengths from the top, middle and bottom, cutting midway between the joints, and this portion divided into four equal parts by quartering, one part being taken for analysis. The sample should be so taken that the portion reserved for analysis is about 500 grams.

The whole sample of cane is first weighed, then finely cut and treated with cold water for two hours, changing the water every half hour, or, if preferred, placing the sample in a linen bag and treating with running water for the same length of time. It is then to be digested with water at 60° to 70° C. for one hour, changing the water every fifteen minutes, then with boiling water for one hour, changing every fifteen minutes, and dried to constant weight at 100° C.

In determining the fibre in the cane, the amount of field trash weighed with the cane should be determined once a day on one average car, the amount of fibre determined, and this added, pro rata, to the amount of fibre found in the sample of clean cane.

JUICE.

Juice samples should be taken continuously by some automatic sampling device, and run into a container containing a sufficient quantity of either mercuric chloride or formalin. The density should be taken with a Brix. spindle graduated at 27½° C., and correction made for temperature. Before taking the density the juice should be freed from air, particles of trash removed from the top and sand or dirt allowed to settle.

For the determination of sucrose, the juice may be either weighed or measured, using 100 cc. or double the normal weight as measured in a sucrose pipette. No more acetate of lead should be used than is sufficient to effect clarification. Juice samples should be analysed at least every six hours.

BAGASSE.

Bagasse should be sampled at the carrier, the whole amount from one slat being taken, well mixed and placed in a close container. Samples should be taken at least every six hours and analysed separately.

Sucrose in bagasse. Fifty grams are taken, placed in a tared litre flask, 450 cc. water added, the solution made slightly alkaline with 5 cc. of a five per cent. solution of sodium carbonate, the flask connected with a vertical condenser and boiled slowly for one hour. After cooling, the flask and contents are weighed, the diffused liquor strained, 99 cc. placed in a 100 cc. flask, clarified with a few drops of acetate of lead, filtered and polarised. The polariscope reading, divided by 3·8, gives per cent. sucrose in diffused liquor. Grams of diffused liquor times per cent. of sucrose in diffused liquor = grams sucrose in diffused liquor, and

$$\frac{\text{Grams sucrose in diffused liquor} \times 100}{\text{Grams bagasse used}} = \%\ \text{sucrose in bagasse.}$$

For example: Bagasse used, 50 grams. Bagasse contains 52 % fibre

	Grams.
Flask + bagasse + water	626
Flask..	126
Bagasse + diffused liquor	500
Fibre in bagasse	26
Diffused liquor	474

and for 100 grams bagasse we have diffused liquor 948 grams.

If polariscope reading is 1°, we have % sucrose in diffused liquor $= 0{\cdot}263$ and $\frac{948 \times 0{\cdot}263}{100} = 2{\cdot}49$ % sucrose in bagasse.

Density of residual juice. The density of the residual juice in the bagasse is found by carrying out the diffusion outlined above, without the addition of sodium carbonate, determining the density of the diffused liquor with a pyknometer, and finding the Brix. corresponding to the specific gravity. For instance, if in the example given above the Sp. Gr. is found to be 1·0028, this corresponds to Brix. ·564, and the Brix of the residual juice will be $\frac{{\cdot}564 \times 948}{100} = 5{\cdot}34$.

Purity of residual juice is then expressed:

$$\frac{\%\ \text{Sucrose in diffused liquor} \times 100}{\text{Brix. diffused liquor}}$$

For moisture in bagasse a portion should be dried to constant weight at 100° C.

Extraction.

By extraction is meant the percentage of sucrose in the cane which is obtained in the mixed juice. When the term extraction is used in any other sense, it should be so defined.

Having the % sucrose in the cane from the formula

$$\%\ \text{sucrose in cane} = \frac{\%\ \text{sucrose in normal juice } (100-\text{F})}{100}$$

and the % sucrose in the mixed juice by analysis, the calculation of extraction is simple, being expressed

$$\frac{\%\ \text{sucrose in mixed juice} \times \text{wt. of mixed juice} \times 100}{\%\ \text{sucrose in cane} \times \text{wt. of cane}}$$

Where it is not possible to weigh the cane, this weight may be calculated from the sucrose in the mixed juice and the % sucrose extracted per 100 cane.

Below is an example full enough to need no explanation.

Normal juice density Brix.	18·58
Mixed juice density Brix...	16·76
Sucrose	15·71
Purity	93·70
Residual juice purity	78·00
Extraction assumed	93·00
Cane per cent. fibre..	11·5
Bagasse—sucrose..	4·14
Moisture	46·36

Purity of cane juice (normal juice): $\frac{(93{\cdot}7 \times 93) + (78 \times 7)}{100} = 92{\cdot}6$

Sucrose % normal juice: $\frac{18{\cdot}58 \times 92{\cdot}6}{100} = 17{\cdot}21$

Sucrose % cane: $\frac{17{\cdot}21 \times (100 - 11{\cdot}5)}{100} = 15{\cdot}23$

Soluble solids % bagasse: $\frac{4{\cdot}14 \times 100}{78} = 5{\cdot}31$

Insoluble solids % bagasse: $100 - (46{\cdot}36 + 5{\cdot}31) = 48{\cdot}33$

Bagasse % cane: $\frac{11{\cdot}5 \times 100}{48{\cdot}33} = 23{\cdot}79$

Sucrose in bagasse % cane: $\frac{23{\cdot}79 \times 4{\cdot}14}{100} = {\cdot}985$

Extraction % cane: $15{\cdot}232 - {\cdot}985 = 14{\cdot}245$

Extraction % sucrose in cane: $\frac{(15{\cdot}23 - {\cdot}985) \times 100}{15{\cdot}23} = 93{\cdot}53$

Juice lbs.: 5,364,500

Sucrose in juice lbs.: $\frac{5{,}364{,}500 \times 15{\cdot}71}{100} = 842{,}762$

Sucrose in cane lbs.: $\frac{842{,}762 \times 100}{93{\cdot}53} = 901{,}060$

Cane lbs.: $\frac{901{,}060 \times 100}{15{\cdot}23} = 5{,}916{,}349$

Waste Molasses.

Total solids. The total solids in molasses are to be determined in the following manner: About two grams of filter paper are crumpled or coiled, tied with thin wire and dried. This is weighed in a tared test tube 5 in. × 1 in. The paper is then removed and about two grams of molasses are weighed in the tube and mixed with 2 cc. of hot water. The paper is replaced evenly in the tube and absorbs the whole of the liquid. The tube is then stoppered with a doubly perforated stopper, placed in a water bath, and the water kept boiling for 2½ hours, a slow current of air, dried over calcium chloride or sulphuric acid, being drawn through the tube. The tube is weighed

after cooling and the loss stated as water, the difference between the weight of molasses taken and the weight of water stated as total solids.

Aliquot samples should be taken daily and the total solids determined in the accumulated samples once a week.

For daily reports the solids may be determined by dilution and spindling, diluting the molasses with its own weight of water, using a Brix spindle graduated at $27\frac{1}{2}°$ C., correcting for temperature, and doubling the reading for the solids in the original molasses.

Sucrose in molasses. Sucrose is to be determined by the Clerget method, using either neutral acetate of lead or sub-acetate with acetic acid for clarification.

Press Cake.

Sucrose in press cake. Take 25 grams of sample, beat to a thin paste with hot water, transfer to a 100 cc. flask, cool, add acetate of lead, then acetic acid to set free any combined sucrose, make to volume, filter and polarise, stating the reading as % sucrose.

Moisture in press cake. Thirty grams are dried to constant weight at 100° C.

Where it is not possible to weigh the press cake, one average cake should be weighed each day and this taken as the basis of calculation.

Polarisation, General.

Clarification. Neutral acetate of lead or sub-acetate with acetic acid, should be used as the clarifying reagents in preparing solutions of all sugar house products for polarisation.

Readings. All solutions should be polarised immediately after they are prepared. A number of polariscope readings should be taken for each tube and the mean taken as the true polarisation.

Quartz plates. Quartz plates used for control should be compared with some standard plate at a central station. The Director of the Planters' Experiment Station has such standard plates.

Entrainment.

A continuous sample of the evaporated water should be taken and analysed every six hours. Two litres are evaporated to 100 cc. and the sucrose determined either by polarisation, or by inversion, and determination of the invert sugar by Fehling's Solution.

Dilution.

Dilution is to be stated as dilution of the normal juice, as follows:

$$\frac{\text{Brix mixed juice} \times 100}{\text{Brix normal juice}} - 100$$

Hawaii is just now troubled with a bad pest locally termed the Leaf Hopper. It is said to be doing considerable damage to the canes in consequence of which this year's crop will be much smaller than that of 1903.

THE PROGRESS OF EXPERIMENTAL SUGAR BEET CULTURE IN THE UNITED KINGDOM.

(Continued from page 146.)

I will now conclude, as I have said, by touching upon the vast importance of sugar manufacture as a national industry. By the Sugar Bounty Convention we have, placed as it were in our hands, the power, not only of recrudescing sugar refining, but of entering forthwith into the profitable manufacture of sugar.

The cost of sugar-making per ton of roots works out as follows:—

		£	s.	d.
Fuel, 12 per cent. coal at 7s. per ton		0	0	10
Wages:—				
First process—preparative		0	0	8
Second process—completive		0	0	10
Limestone, 4 per cent., at 6s. per ton delivered ..		0	0	3
Coke	2·30d.			
Leather and filter cloth	0·60			
Bags	1·92			
Oil and Grease	0·55	0	0	9
Light	0·45			
Various materials	0·62			
Laboratory	0·56			
Selling commission..	2·00			
Sundry expenses		0	0	3
Expenses of office, management, &c...		0	2	5
Total		0	6	0

The average weight of coal required is from 10 to 12 per cent. of the weight of the beetroots, whilst about 4 per cent. of their weight is sufficient in limestone, about 5 per cent. of the weight of the roots of coke being necessary for burning the lime.

With a 13·3 percentage of saccharine, 7·5 tons of beetroots are required for the production of each ton. The cost in this case of producing a ton of sugar is:—

	£	s.	d.
7·5 tons of roots at 18s.	6	15	0
Expenses of making, at 6s. per ton of roots ...	2	5	0
Total	£9	0	0

Taking the case of a factory capable of dealing with 40,000 tons of roots per annum its balance-sheet would therefore be as follows:—

FACTORY DEALING WITH 40,000 TONS OF BEETROOTS PER ANNUM.

Dr.	£	s.	d.	Cr.	£	s.	d.
Cost of beetroots, including expenses, 40,000 tons at 24s. ..	48,000	0	0	5,200 tons sugar produced, at £9 per ton	46,800	0	0
5 per cent. depreciation .. .	3,000	0	0	800 tons molasses, at 2s. 4d. per cwt.	1,850	0	0
Profit	3,650	0	0	12,000 tons slices, 30 per cent. at 10s. per ton ..	6,000	0	0
	£54,650	0	0		£54,650	0	0

The capital expenditure necessary for such a factory to be erected in the very latest style, and equipped in a thoroughly scientific manner with all modern improvements in plant and machinery, would be £60,000. Carried on under proper scientific and technical control, this should yield a profit of £3,600 per annum, and produce a dividend of about 6 per cent.

This is not a very high rate of interest for an industrial undertaking, but in these days, if combined with safety, it would be very acceptable. Probably there is no safer industry, for sugar is a *necessity*—a great thing in business. It is, moreover, a commodity of universal consumption.

I am, however, purposely looking at the least favourable side of things all through, and it would be well to consider this point a little more minutely. The result of so doing, it will be seen, is to add to its complexion an even more roseate hue; for we have to consider what will, in all probability, be the effect of this altered state of affairs concerning bounties upon sugar. Through the abrogation of the bounties, it is probable that the figure taken will be not only reached, but that it will be much exceeded. In regard to sugar, overproduction has, of course, been rife for some years; but a continental expert of large experience tells me, as his private opinion, that in future the prices ruling will be from £9 to £9 10s. a ton, once the present large stocks are cleared from the market, seeing that at that price it would produce a fair profit to the continental manufacturers.

There is yet, however, another important point I must not omit to bring forward and briefly consider. It is this: that by the Brussels Convention, it has been agreed between the Powers concerned, of which Great Britain is one, that all home-grown sugar should be entitled to remission at the rate of six francs per 100 kilos—equivalent, that is, to 2s. 6d. per cwt.—from whatever tax might be levied by the country of its origin. Now, Great Britain, as a signatory of the Convention, must, when occasion arises, accord this remission to her manufacturers. At present a tax of 4s. 2d. per cwt. is levied by

us upon *all* sugar. Now, *ceteris paribus*, by the abovementioned clause the tax on home-grown sugar should be reduced by half-a-crown—*i.e.* it should be 4s. 2d. less 2s. 6d., viz., 1s. 8d. per cwt.

Now, this is an important matter, for the remission of 2s. 6d. per cwt. obviously means no less than £2 10s. a ton in favour of the British sugar-maker. The full significance of this may perhaps be more readily seen and better understood if one shows the price which would have to be paid by the consumer for sugar in such case.

	£	s.	d.	£	s.	d.
For foreign sugar, at £9 per ton	9	0	0			
With duty at 4s. 2d. per cwt.	4	3	4			
Price to consumer..				13	3	4
For British sugar, at £9 per ton	9	0	0			
With adjusted duty at 1s. 8d. per cwt.	1	13	4			
Price to consumer				10	13	4
Difference				£2	10	0

This being interpreted, means, not only that the British sugar manufacturer could make his fair profit, but could supply the English consumers at no less than £2 10s. per ton cheaper.

Now let us take the case of a still lower figure as the price at which continental sugar could be supplied—say £8 per ton. This, with the duty added, would mean the price of £12 3s. 4d. to the consumer. British sugar obviously could be sold at the same figure—£12 3s. 4d., less £1 13s 4d., or £10 10s., as the price obtained by the producer. To amplify this I have drawn up the following Table, by which it is seen the price which would be obtainable for British sugar under the circumstances corresponding to different rates of prices of continental sugar:—

Continental.			Duty.			Price paid by Consumer.			British.			Duty.			Price paid by Consumer.		
£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
6	10	0	4	3	4	10	13	4	9	0	0	1	13	4	10	13	4
7	0	0	,,			11	3	4	9	10	0	,,			11	3	4
7	10	0	,,			11	13	4	10	0	0	,,			11	13	4
8	0	0	,,			12	3	4	10	10	0	,,			12	3	4
8	10	0	,,			12	13	4	11	0	0	,,			12	13	4
9	0	0	,,			13	3	4	11	10	0	,,			13	3	4
9	10	0	,,			13	13	4	12	0	0	,,			13	13	4
10	0	0	,,			14	3	4	12	10	0	,,			14	3	4

Now let us again review the position of the prospective British sugar-manufacturer. It has been shown that at £9 per ton he could make six per cent.; but with sugar at £10 a ton the proportional increased earnings would raise his profit to 14¾ per cent., with sugar at £11 it would become 23·4 per cent., whilst with £12 sugar it would be increased to no less than 32 per cent. Even under the very satisfactory condition of things where a high rate of interest could be paid

to the investor, resulting in the introduction of an enormous industry into our country, the consumer would still only have to pay about the same for his sugar as if we continue to remain somnolent, and content ourselves merely with writing cheques for a commodity we could produce ourselves.

From the foregoing facts and figures I trust it may have been shown that we now have it in our power to inaugurate and introduce a vast industry into our country. Its magnitude, however, in its full significance, may not be readily apparent to the non-technical. It is, however, brought home to us at once if we consider the enormous annual consumption of sugar in this country alone.

We consume every year 1,500,000 tons of sugar. To produce this amount would give employment to no less than 300 factories, each capable of turning out 5,000 tons per annum, and affording profitable use for twenty-four millions of capital. To grow the requisite beets, no less than a million acres of land might be brought under cultivation for this crop alone. Now, seeing that it requires a man to every five acres of beetroot farm, this would give employment to no less than two hundred thousand agricultural labourers. These vast advantages—one must not omit to point out—would be permanent gains despite their vastness, but to them should also be added the enormous benefits which would accrue during inception to our building trades and to our engineering concerns.

Turning to the reintroduction of the lost industry of sugar-refining, we find that to deal with the sugar of our own manufacture would require thirty refineries. These would cost another £3,600,000 to build and equip. Hence, the total capital value of the industry to our nation would be £27,600,000. The manufacture would enable us to pay out in wages at least £5,000,000 a year to operatives immediately concerned. But to this must also be added the wages of the men required to supply the factories with 2,000,000 tons of coal, 1,500,000 tons of limestone, and 400,000 tons of coke, which would be consumed during the manufacture every year.

There is, therefore, no reason whatsoever why we should pay away the huge sum of *eighteen million pounds* every year—as we are now paying—to the continental agriculturists and foreign sugar manufacturers. All of this could be spent in our own country. And what would this mean? It would mean that, by an indirect means we should be able to resuscitate our once great, but fast-decaying, agriculture; we should be able to pay armies of additional artisans; and we should be able so to increase the wages of our agricultural labourers that they would be able to live in comfort and comfortable homes, such as it is intended Garden Cities shall set the example in providing.

In Formosa five sugar houses are to start for the next campaign.

REPORT ON THE SUGAR BEET GROWING EXPERIMENTS IN GREAT BRITAIN AND IRELAND, 1903.

By SIGMUND STEIN, Liverpool.

In publishing this the ninth report of my sugar beet growing experiments in the United Kingdom, for the year 1903, I may say that I have achieved results which surpass in every way my previous experiments.

My farmer friends did their best to grow roots, and the results which I now publish show that they can compete successfully with their Continental confrères.

In general the roots were well-shaped and showed satisfactory saccharine contents and weight.

I may say that I have grown sugar beetroots in almost every part, every county in England, Scotland and Ireland, and have established a practical knowledge about beet growing throughout the United Kingdom. It was rather a difficult task to undertake, but with persistent work, close attention to the serious matter I have in view brought a success of which British agriculture can well be proud. I have stated over and over again that the question of establishing a British beet sugar industry is a national one, and one of national importance.

I am sure that the time is not far off when we shall see beet sugar factories working in these islands, and that we shall show our independence by producing all the sugar required for home consumption.

Such great interest is manifested in my experiments as I am inundated with letters from all parts of the country, showing the interest taken in this important question. I have been asked by leading men in the country to continue my experiments next season, and in spite of the heavy work which these experiments involve I cannot do otherwise than follow the suggestions laid before me.

As in former years different kinds of seeds have been used, and I would draw special attention to the disinfected kind of Aderstedt, which show exceptionally good results.

This year a greater variety of seeds have been used than in previous years, on account of my desire to study the results obtained from their use in different counties and under different conditions. Soil and manure varied also this year.

I regret to find that I have by me, as in past years, many parcels of roots which reached me without the necessary data to enable me to forward my results of analysis to the experimenters. Should the senders furnish me with such particulars as would lead to the identification of the parcels they forwarded, I could after receipt of such particulars forward them my report.

There have been this year fifty-two experiments—*i.e.*, thirty-five in England, fifteen in Scotland, and two in Ireland.

As in previous years, I have compared my analysis with those of Mr. F. O. Licht, Magdeburg, and I give below the comparative results:—

COMPARATIVE RESULTS.

	British Grown Roots. 1903.		German Grown Roots. 1903.
Average weight of roots, without leaves, in grammes	933	..	560
Quantity of sugar in 100 parts of the juice.	17·28	..	16·87
Quantity of non-sugar in 100 parts of the juice	2·65	..	3·83
Quotient of purity	86·98	..	85·63

Regarding the quantity of juice and pulp, the average in 1903 was as follows:—

	British.
Juice	92·88
Pulp	7·12
	100·00

I would invite the reader, as figures speak best for themselves, to compare the above and make his own conclusions.

I have conclusively proved that our climate, our soil, and our conditions are quite suitable for sugar beet growing, and that we can produce better roots than our Continental competitors.

The country may now be considered ripe for the establishing of a gigantic industry, as our farmers are educated, labour is plentiful, and the capital would be forthcoming.

With regard to the tonnage per acre, British grown roots in my experiments have yielded as:—

	Tons.		Tons.
1897	16·07	1901	19·04
1898	16·03	1902	15·90
1899	16·09	1903	14·50
1900	19·01		

The tonnage this year is smaller than previous years; but, as is well known, the season was very unfavourable. In spite of all, such a tonnage leaves little to be desired, as it is very satisfactory.

I will not repeat the figures already given in the various publications laid before the public, but would simply add that the sympathisers with my scheme increase year by year, and many letters are to hand asking for a copy of this year's report. This shows clearly that the scheme is becoming a subject of interest not only to agriculturists, but to manufacturers and capitalists as well.

The Brussels Convention of March, 1902, has removed many obstacles to the starting of this industry in the United Kingdom, and I cannot do better than refer to the discussion on the sugar question in our Parliament, in which it was clearly stated and proved that with the fall of the bounties the introduction of the sugar beet industry would be secured.

ANALYSIS OF SUGAR BEETROOT.

ENGLAND.

Reference No.	The Trials were made by	Farming at	What kind of Soil.	What Manure was used, and How much per Acre.	Yield of Roots per Acre in Tons.	Length of time of Vegetation.
						Days
1	The Right Hon. The Earl of Denbigh	The Newnham Home Farm, Warwick	Sandy loam, sandy subsoil	$6\frac{1}{2}$ cwt. Proctor & Ryland's manure, 1 cwt. nitrate of soda	16·75	153
2	,, ,, ..	Pailton Field Farm, Rugby, Warwickshire	Stiff loam, clay subsoil	15 tons farmyard manure, 3 cwt. superphosphate, $1\frac{1}{4}$ cwt. sulphate of ammonia	10·75	186
3	,, ,, ..	High Cross Farm, High Cross, Rugby, Warwickshire	Heavy loam, clay subsoil..	12 loads farmyard manure, 3 cwt. superphosphate, 2 cwt. kainit	13·	180
4	,, ,, ..	Kirby Manor, Monk's Kirby, Warwickshire	Heavy loam, yellow clay subsoil	10 loads farmyard manure, 6 cwt. Proctor & Ryland's mangold manure	12·	174
5	,, ,, ..	Brockhurst Farm, Lutterworth, Warwick	Sandy loam, gravel subsoil	12 loads farmyard manure, 3 cwt. superphosphate, 1 cwt. Peruvian guano	13·	123
6	The Right Hon. The Earl of Lathom	Crams Farm, Ormskirk, Lancashire	Light sandy subsoil	20 tons farmyard manure, 5 cwt. Proctor & Ryland's manure	19·	141
7	The Corporation of Liverpool	West Derby Sewage Farm, Fazakerley, Lancashire	Light sandy loam, subsoil sandy	Sewage only..................................	14·85	186
18	W. F. Lawrence, Esq , M.P..	Cowesfield Farm, Wiltshire..	Medium loam, subsoil chalk and clay	Farmyard manure, also 2 cwt. phosphate and 2 cwt. bones	10·50	175
26	Thomas Golding, Esq.	Tree Farm, Plantol, Sevenoaks, Kent	Stone shattery, medium loam, subsoil Kentish ragstone	Farmyard manure, with artificial dressing	10·	155
28	Hon. F. C. Wynn, per Professor Thomas Winter	Glynllivon Home Farm, Carnarvon, N. Wales	Light fibrous loam, subsoil gravel	None	11·25	172
29	,, ,, ..	,, ,, ..	,, ,, ..	3 cwt. superphosphate and 1 cwt. sulphate of potash	10·90	172
30	,, ,, ..	,, ,, ..	,, ,, ..	6 cwt. superphosphate and 2 cwt. sulphate of potash	11.20	172
31	,, ,, ..	,, ,, ..	,, ,, ..	6 cwt. superphosphate, 2 cwt. sulphate of potash, 1 cwt. nitrate of soda	13·85	172
32	R. H. Greaves, Esq., per Professor Thomas Winter	Wern, Portmadock, North Wales	Stony loam, subsoil shaly..	None	..	164
33	,, ,, ..	,, ,, ..	,, ,, ..	3 cwt. superphosphate and 1 cwt. sulphate of potash	12·25	164
34	,, ,, ..	,, ,, ..	,, ,, ..	6 cwt. superphosphate and 2 cwt. sulphate of potash	8·80	164
35	,, ,, ..	,, ,, ..	,, ,, ..	6 cwt. superphosphate, 2 cwt. sulphate of potash, 1 cwt. nitrate of soda	11·10	164

Reference No.	Previous Crop.	F. O. Licht, Magdeburg.				Klein Wanzleben.					Vilmorin Rouge.					Klein.				
		Average weight in grammes.	Sugar in 100 parts of juice.	Non-Sugar in 100 parts of juice.	Purity.	Average weight in grammes.	Sugar in 100 parts of juice.	Non-Sugar in 100 parts of juice.	Purity.	Sugar in 100 parts of roots.	Average weight in grammes.	Sugar in 100 parts of juice.	Non-Sugar in 100 parts of juice.	Purity.	Sugar in 100 parts of roots.	Average weight in grammes.	Sugar in 100 parts of juice.	Non-Sugar in 100 parts of juice.	Purity.	Sugar in 100 parts of roots.
1	Wheat	560	16·87	2·83	85·83	1310	19·30	2·40	88·94	18·40	..	..	..	..	..	..	..	..	..	..
2	,, ...	560	16·87	2·83	85·83	956	19 20	2·60	87·61	18·00	..	..	..	..	..	..	..	..	..	..
3	Tares	560	16·87	2·83	85·83	1141	16·80	2·30	87·95	16·00	..	..	..	..	..	..	..	..	..	..
4	Wheat	560	16·87	2·83	85·33	1182	18·40	2·30	88·88	17·70	..	..	..	..	..	..	..	..	..	..
5	Oats	560	16·87	2·83	85·83	1242	18·00	2·20	89 10	17·10	..	..	..	..	..	..	..	..	..	..
6	Wheat	560	16·87	2·83	85·83	..	..	..	..	..	1126	17 20	3·00	85·14	16·40	..	..	..	..	..
7	Italian ryegrass	560	16·87	2·83	85·83	..	..	..	..	..	..	..	..	..	..	1116	17·00	2·61	86·73	17·10
18	Wheat	560	16·87	2·83	85·83	..	..	..	..	..	955	18·90	2·90	86·69	17·90	..	..	..	.	..
26	Potatoes	560	16·87	2·83	85 83	888	17·70	2·90	85·92	17·00	..	..	..	..	..	..	..	..	..	..
28	Oats and pasture........	560	16·87	2·83	85·83	632	19·00	2·70	87·55	18·10	..	..	..	..	..	..	..	..	..	..
29	,, ,, ...	530	16·87	2·83	85·83	744	18·90	3·30	85·13	18·00	..	..	..	..	..	..	..	..	..	..
30	,, ,, ...	560	16·87	2·83	85·83	682	16·70	2·90	85·20	16·00	..	..	..	..	..	..	..	..	..	..
31	,, ,, ...	560	16·87	2·83	85 83	732	18·30	3·60	87·56	17·50	..	..	..	..	..	..	..	..	..	..
32	,, ,, ...	560	16·87	2·83	85·83	482	18·20	2·40	88·35	17·60	..	..	..	..	..	..	..	..	..	..
33	,, ,, ...	560	16·87	2·83	85·83	493	16·90	2·70	86·22	16·22	..	..	..	..	..	..	..	..	..	..
34	,, ,, ...	560	16·87	2·83	85·83	567	19·70	2·90	87·17	19·10	..	..	..	..	..	..	..	..	..	..
35	,, ,, ...	550	16·87	2·83	85·83	566	19·50	2·20	89·86	18·10	..	..	..	..	..	..	..	..	..	..

ENGLAND.—*Continued.*

Reference No.	The Trials were made by	Farming at	What kind of Soil.	What Manure was used, and How much per Acre.	Yield of Roots per Acre in Tons.	Length of time of Vegetation.
						Days
11	The Corporation of Liverpool	Walton Sewage Farm, Kirkby, Lancashire	Strong top, clay subsoil ..	Sewage only........................	..	163
12	" " ..	" " ..	" " ..	Ditto	31·30	166
15	W. F. C. Moers, Esq., J.P. ..	Tweet Estate, Boldre, Lymington, Hants	Loam subsoil, clay over sand, no lime in soil	20 loads farmyard, ½ cwt. sulphate of ammonia, 1 cwt. dissolved bones, 1 cwt. salt, and 2 cwt. 4 lbs. gypsum	17·	180
16	" " ..	" " ..	Loamy sand, subsoil gravel, no lime in soil	Ditto ditto	18·	176
17	" " ..	" " ..	Sandy loam, sand subsoil, no lime in soil	Ditto ditto	16·50	177
19	Rev. Edw. Muckleston, Esq., M.A.	Glebe Farm, Hosely, Warwickshire	Black bog or moorland....	None	16·	127
22	Treherne Thomas, Esq.......	Formby, own land, Liverpool, Lancashire	Sandy, briny, cold subsoil.	Horse manure	17·	169
21	C. F. Ellis, Esq.	Minster Lodge, Ormskirk ..	Black	Stable manure........................	17·	160
23	William Hodson, Esq.	Tedworth Farm, Epsom, Surrey	Gravel, subsoil chalk......	15 tons farmyard manure	11·	191
24	Thomas Bamford, Esq.......	Own Farm, Bretherton, Lancashire	Strong black..............	Half farmyard and half Thomas & Co.'s Anti-pest Fertilizer powder	23·	184
25	Richard Brade, Esq.	Own Farm, near Southport, Lancashire	Black putty	Half farmyard and some Thomas's Antipest .	29·	183
27	Rossiter Gibbon, Esq........	"Rousse," Vale Parish, Guernsey	Sand subsoil, decayed granite, brown coarse sand, tenture	9 cwt. kainit and superphosphate, 2 cwt. 2 qrs. 20 lbs. nitrate of soda	21·	153
8	The Corporation of Liverpool	West Derby Sewage Farm, Fazakerley, Lancashire	Light sandy loam, subsoil sandy	Sewage only........................	13·40	186
9	" " ..	" " ..	" " ..	Ditto	16·80	186
10	" " ..	" " ..	" " ..	Ditto	18·70	186
14	John Woolston, Esq., J.P. ..	Sydney College Farm, near Stamford, Lincolnshire	Light subsoil, lime........	Farmyard and artificial turnips manure	14·	158
13	The Corporation of Liverpool	Walton Sewage Farm, Kirkby, Lancashire	Strong top, clay subsoil ..	Sewage only........................	..	166
20	The Corporation of Northampton	Irrigation Farm, Ecton, Northampton	Deep black................	Liquid sewage........................	23·75	172
	Average of the 35 Experiments in England			....	15·70	170

Reference No.	Previous Crop.	F. O. Licht, Magdeburg,				Vilmorin Blanche.					Aderstedt (Disinfected).					Schlieckmann.				
		Average weight in grammes.	Sugar in 100 parts of juice.	Non-Sugar in 100 parts of juice.	Purity.	Average weight in grammes.	Sugar in 100 parts of juice.	Non-Sugar in 100 parts of juice.	Purity.	Sugar in 100 parts of roots.	Average weight in grammes.	Sugar in 100 parts of juice.	Non-Sugar in 100 parts of juice.	Purity.	Sugar in 100 parts of roots.	Average weight in grammes.	Sugar in 100 parts of juice.	Non-Sugar in 100 parts of juice.	Purity.	Sugar in 100 parts of roots.
11	Sugar beet	530	16·87	2·83	85·63	1426	17·10	2·70	86·36	16·40	..	..	..	..	..	..	..	..	..	..
12	,, ,, ...	560	16·87	2·83	85·63	..	..	..	..	..	..	..	..	..	..	1167	17·90	2·90	86·06	17·00
15	,, ,, for 25 years .	560	16·87	2 83	85·63	..	..	..	..	..	797	17·80	3·10	85·17	17·20	..	..	..	..	..
16	,, ,, ,, ..	560	16·87	2·83	85·63	..	..	..	..	..	888	18·50	2·90	86·44	18·00	..	..	..	..	..
17	,, ,, ,, ..	560	16·87	2·83	85·63	..	..	..	..	..	976	17·80	2·60	87·25	17·10	..	..	..	..	..
19	Turnips and cabbage	560	16·87	2·83	85·63	936	18·30	2·60	87·56	17·40	..	..	..	..	..	..	..	..	..	..
22	Sugar beet	560	16·87	2·83	85·63	..	..	..	..	..	..	..	..	..	..	1032	16·80	2·60	86·54	16·20
21	Celery	560	16·87	2·83	85·63	..	..	..	..	..	..	..	..	..	..	910	16·80	2·90	85·27	16·00
23	Wheat	560	16·87	2·83	85·63	..	..	..	..	..	819	18·40	2·20	89·32	17·70	..	..	..	..	..
24	Oats	560	16·87	2·83	85·63	..	..	..	..	..	1529	16·00	2·50	86·48	15·50	..	..	..	..	..
25	,, ...	560	16·87	2·83	85·63	..	..	..	..	..	..	..	..	..	..	1940	14·40	2·50	85·21	13·70
27	Radish	560	16·87	2·83	85·63	..	..	..	..	..	..	..	..	..	..	1187	16·30	2·60	86·24	15·60
						Braune.					Wohanka.					Breustedt.				
8	Italian ryegrass	560	16·87	2·83	85·63	1316	16·70	2·20	83·35	16·00	..	..	..	..	..	..	..	..	..	..
9	,, ,, ...	560	16·87	2·83	85·63	..	..	..	..	..	..	..	..	..	..	1144	19·40	2·90	86·99	18·20
10	,, ,, ...	560	16·87	2·83	85·63	..	..	..	..	..	956	16·70	2·70	86·08	16·10	..	..	..	..	..
14	Barley	560	16·87	2·83	85·63	966	16·80	2·70	86·15	16·30	..	..	..	..	..	..	..	..	..	..
						Aderstedt.														
13	Sugar beet	560	16·87	2·83	85·63	1033	19·30	2·40	88·94	17·90	..	..	..	..	..	..	..	..	..	..
20	Cabbage	560	16·87	2·83	85·63	967	19·20	2·40	88·88	18·40	..	..	..	..	..	..	..	..	..	..
	Average of the 35 Experiments in England ..				..	..	..	..	..	..	995	17·85	2·66	87·06	17·05	..	..	..	..	..

SCOTLAND.

Reference No.	The Trials were made by	Farming at	What kind of Soil.	What Manure was used, and How much per Acre.	Yield of Roots per Acre in Tons.	Length of time of Vegetation.
						Days
35	Alexander Leake, Esq.	Haddo House, Old Mill, Schivas, Aberdeenshire	Light loam, subsoil sandy.	Potato manure	13·	174
39	William Reith, Esq.	On the Estate of Leys, Kincardineshire	Light sandy, subsoil pan ..	Farmyard manure, 3 cwt. Peruvian guano, 2 cwt. turnips manure	18·	163
40	Allan M. Douglas, Esq......	Spotsmain, Kelso, Roxburghshire, N.B.	Good loamy, subsoil clay..	Farmyard with top dressing, 2 cwt. salt, and 1 cwt. nitrate of soda	18·50	182
41	Messrs. J. & J. R. C. Smith..	Farm of Galalow, Roxburghshire, N.B.	Medium clay, subsoil clay.	Farmyard manure, $3\frac{1}{2}$ cwt. superphosphate, $1\frac{1}{2}$ cwt. sulph. of potash, $\frac{3}{4}$ cwt. Ichaboe guano	14·50	176
42	John M. Potter, Esq.........	Boghead South, Kimmerndy. Aberdeenshire, N.B.	Sharp mould, subsoil hard clay	Farmyard with 6 cwt. bone dust, superphosphate, and sulphate of ammonia	15·50	109
47	J. Douglas Fletcher, Esq....	Mains of Rosehaugh, Avoch, Ross-shire, N.B.	Heavy black loam on gravel subsoil	Farmyard with top dressing, mixture kainit super'phate, dis. comp. (bone), & nitr. of soda	14·	179
48	James Wyness, Esq.	Ballafald, Bridge of Doon, Aberdeenshire	Brown loam	Farmyard manure	17·	137
37	William Robert Murray, Esq.	Bettyfield, Mellerstein Estate, Roxburghshire	Sandy loam, subsoil red sand	$\frac{1}{2}$ cwt. sulph. of ammonia, 1 cwt. sulph. of potash 2 cwt. superphosphate, 1 cwt. bone flour	12·	184
38	George Cooper, Esq.	Candy, Glerach Farm, Drumoak, Aberdeenshire	Old black soil, subsoil very hard	Farmyard and potato manure	8·	162
43	The West of Scotland Agricultural College	Experim'tal Station, Holmes Farm, Kilmarnock	Good loam, subsoil hard, gravelly	Farmyard manure, also 5 cwt. superphosphate' $2\frac{1}{2}$ cwt. kainit, 1 cwt. sulphate of ammonia' 6 cwt. nitrate os soda	14·	204
44 46	J. Douglas Fletcher, Esq. ..	Mains of Rosehaugh, Avoch, Ross-shire	Heavy black loam on gravel subsoil	Ditto ditto .... Farmyard manure with top dressing, and mixture of kainit, superphosphate, dis. comp. (bone), and nitrate of soda	14· 14·	204 179
49	William Forrest, Esq.	Kincorth, Abbotswell, Aberdeenshire	Sandy loam	20 tons farmyard manure, 3 cwt. bone	9·75	132
45	J. Douglas Fletcher, Esq. ..	Mains of Rosehaugh, Avoch, Ross-shire	Heavy black loam on gravel subsoil	Farmyard manure with top dressing, and mixture of kainit, superphosphate, dis. comp. (bone), and nitrate of soda	14·	179
50	James Hardie, Esq.	Harehill, Parkhill Estate, Aberdeenshire	Sharp thin, subsoil pan ..	Farmyard manure and 6 cwt. bone meal phosphate	15·	127
	Average of the 15 Experiments in Scotland		....	....	14·68	166
			IRELAND.			
51	The Right Hon. Lord Carew.	Castleboro' Farm, Wexford ..	Light clay, gravel subsoil..	26 tons farmyard manure, 6 cwt. bone manure..	16·	189
52	Charles McCoy, Esq........	McCoy Farm, Knox Estate, co. Sligo	Loam, subsoil gravel	Composite garden soil and fowl droppings	24·	151
	Average of the 2 Experiments in Ireland				20·	170
	Average of the 52 Experiments in the United Kingdom on the Year 1903				14·50	169
	Compared with German grown roots according to Mr. F. O. Licht, Magdeburg, in the Year 1903				..	..

Reference No.	Previous Crop.	F. O. Licht, Magdeburg.				Aderstedt.					Wohanka.					Breustedt.				
		Average weight in grammes.	Sugar in 100 parts of juice.	Non-Sugar in 100 parts of juice.	Purity.	Average weight in grammes.	Sugar in 100 parts of juice.	Non-Sugar in 100 parts of juice.	Purity.	Sugar in 100 parts of roots.	Average weight in grammes.	Sugar in 100 parts of juice.	Non-Sugar in 100 parts of juice.	Purity.	Sugar in 100 parts of roots.	Average weight in grammes.	Sugar in 100 parts of juice.	Non-Sugar in 100 parts of juice.	Purity.	Sugar in 100 parts of roots.
36	Oats	560	16·87	2·83	85·63	811	16·20	2·30	87·56	15·60	..	..	..	..	..	..	..	..	..	..
39	,, ...	560	16·87	2·83	85·63	..	..	..	..	..	..	..	..	..	..	516	16·70	2·70	86·08	16·00
40	,, ...	560	16·87	2·83	85·63	888	16·30	2·30	87·63	15·40	..	..	..	..	..	..	..	..	..	..
41	Tares	560	16·87	2·83	85·63	..	..	..	..	..	823	19·70	2·90	87·17	19·00	..	..	..	..	..
42	Oats	560	16·87	2·83	85·63	..	..	..	..	..	..	..	..	..	..	619	18·30	2·70	87·14	17·40
47	,, ...	560	16·87	2·83	85·63	..	..	..	..	..	899	17·50	2·90	85·78	16·80	..	..	..	..	..
48	Grass	560	16·87	2·83	85·63	..	..	..	..	..	849	19·90	2·60	87·96	18·20	..	..	..	..	..
											Vilmorin Blanche.					Vilmorin.				
37	Oats	560	16·87	2·83	85·63	834	17·30	3·10	84·80	16·80	..	..	..	..	..	..	..	..	..	..
38	,, ...	560	16·87	2·83	85·63	..	..	..	..	..	489	17·30	2·40	87·81	16·40	..	..	..	..	..
43	,, ...	560	16·87	2·83	85·63	901	17·60	2·70	86·69	17·10	..	..	..	..	..	..	..	..	..	..
44	,, ...	560	16·87	2·83	85·63	777	15·10	2·80	84·36	14·50	..	..	..	..	..	..	..	..	..	..
46	,, ...	560	16·87	2·83	85·63	1011	18·40	3·20	85·19	17·10	..	..	..	..	..	..	..	..	..	..
49	Barley	560	16·87	2·83	85·63	399	16·70	2·70	86·08	16·00	..	..	..	..	..	..	..	..	..	..
45	Oats	560	16·87	2·83	85·63	..	..	..	..	..	..	..	..	..	..	942	16·40	2·30	87·70	15·90
50	,, ...	560	16·87	2·83	85·63	..	..	..	..	..	..	..	..	..	..	1015	17·10	2·30	88·14	16·40
	Average of the 15 Experiments in Scotland			..	..	778	17·30	2·66	86·70	16·57	..	..	..	..	..	..	..	..	..	..
						Breustedt.														
51	Spring oats	560	16·87	2·83	85·63	1117	16·90	2·40	87·56	16·20	..	..	..	..	..	..	..	..	..	..
52	Turnips	560	16·87	2·83	85·63	867	17·30	2·30	88·20	16·60	..	..	..	..	..	..	..	..	..	..
	Average of the 2 Experiments in Ireland..........					..	..	..	..	..	992	17·10	2·35	87·88	16·40	..	..	..	..	..
	Average of the 52 Experiments in the United Kingdom in the Year 1903										933	17·28	2·65	86·98	16·89	..	..	..	..	..
	Compared with German grown roots according to Mr. Licht, Magdeburg, in 1903 ..										560	16·87	2·83	85·63	..	..	..	..	..	..

THE NECESSITY OF CHEMICAL CONTROL IN THE DISTILLERY.

By M. F. Verbièse.*

In a former paper we endeavoured to show what a chemical control should be; on what points of the manufacture and of the distillation it should be particularly employed; and, finally, to what degree of perfection the work may be brought by means of a well arranged control.

A certain number of distillers told us that they had read our paper with interest, but we made this observation: that the persons who appreciated that attempt to diffuse knowledge, belong entirely to the class of distillers who closely watch their fermentations; who know what they leave in their pulps and in their spent-wort; what their beetroots contain of sugar and salt, and what returns they may expect; in a word, they are those who have profited for many years by the resources offered by industrial chemistry for improving their work.

But, in addition to those who endeavour to extract the quintessence of their raw material, there are yet a very large number devoted to obsolete customs, who work by routine as in "the good old times," that is to say, sometimes fairly well, sometimes, and more frequently, badly.

We believe that this indifference is due to their not understanding the difference, which may be proved, between the results of a factory conducted on modern scientific lines and of a factory working the same quantity and quality of roots, but where old-fashioned methods are blindly followed.

This difference is always revealed by an important figure which is occasionally sufficiently high to turn the balance of a crop from the side of profit to that of loss; in certain cases it may reach figures which would appear improbable had they not been proved by irrefutable calculations.

To speak clearly, we stated that during the last few years, when the condition of the industry has been precarious, more than one distillery, working very badly, has resulted in loss; others, working satisfactorily, have made ends meet; whilst others, working very well, have made profits.

It is precisely the importance of this difference which we shall attempt to indicate in the present paper, avoiding technical considerations as far as possible, and considering the practical side of this question.

We shall cite certain anonymous examples, collected here and there during recent years, an account of which will be the most conclusive proof of that which we wish to establish.

* Translated from the *Bulletin de L'Association des Chimistes.*

We shall first of all examine the more apparent losses (visible losses); then study those losses which are only revealed by analysis (invisible losses); and, finally, suggest certain improvements which may be effected in the work of a distillery already conducted in a highly satisfactory manner.

I.—Visible Losses: "Faulty Fermentation."

A common trouble in usines where the work is not submitted to any kind of chemical control.

The distiller makes his evening inspection of the vat house: the evolution of gas is good, the froth white, the vats in active fermentation, giving rapid and low attenuations, the wort clear and of a reddish colour; all goes well and he may sleep peacefully.

Next day the scene is not so enchanting: the foreman, shaking his head, remarks that a "bad humour" reigns in the vat house; the fermentation is less active, the beautiful froth commences to thicken, the attenuations are slow, the wort cloudy; the foreman is not re-assured. Finally we may suppose him to say "perhaps this is due to the working of bad roots."

Two cases present themselves:—

(1.) The defect is due to mere chance and the work recovers its usual activity after a short time. An amusing incident occurs when the distiller, in order to improve the fermentation, makes, or imagines he makes, a radical change in this or that part of the work, or resorts to some empirical process, for he does not fail to attribute the resumed activity of the work to the said changes and will be abashed if his dodge has no effect when, later on, the same trouble recurs and is this time due to a more serious cause.

(2.) The faulty work may be caused by a bacterial infection, the first symptoms of which are now seen; in this case the same cycle of changes are nearly always reproduced: the fermentation becomes more and more sluggish, the wort ropey or cloudy, the attenuations only partial, the acidity in the vats increases—it is true that this is rarely observed, for in certain distilleries the use of the "acidimeter" is still unknown;—the work comes almost to a standstill, in short, the distiller sends for some yeast and starts one or two fresh vats containing small quantities of the wort.

These, having been given the full charge of yeast, start briskly but after adding a certain quantity of wort, fermentation slackens until, the vats being filled, it presents the same appearance as in the older vats. What can be done? Another start is made which, sooner or later, takes the same course as the others, until, weary of the struggle, the distiller decides to call in an expert who, microscope in hand, discovers the sources of the infection and takes the necessary steps to remedy the trouble.

These delays frequently amount to an entire week during which the work is first hindered and finally brought to a stop; the factory hands are paid for doing nothing; the beetroots freeze, sprout, or become spoiled; expenses of various kinds mount up.

Let us attempt to estimate the loss occasioned by an accident of this kind, selecting an average example from those which we have ourselves verified.

Example. The distillery is furnished with vats of 200 hectolitres capacity. The densities in the three last vats have fallen to 0·6, 0·9, and 1·1 degrees at 36° C.

On two different occasions two other vats have been started with fresh yeast, which, commencing well, have finally ceased fermenting with a density of 1·0 degree.

The acidity in the three older vats is 4½ grams H_2SO_4 per litre and in the four new vats 4 grams per litre.

Work began to slacken five days ago. The maceration of the roots has been completely stopped for one day.

1. (*a.*) Loss of alcohol due to incomplete fermentation in the three older vats and the four vats started with new yeast. 1,200 hect. wort reduced in density to 0·9, the normal attenuation being 0·2, therefore seven-tenths of density unfermented, representing 0·85 volume of alcohol per 100 volumes of wort and, therefore, 10·2 hect. alcohol at 100° per 1,200 hect. treated.

(*b.*) Loss of alcohol due to faulty fermentation (a part of the sugar being converted into butyric, lactic and other acids instead of forming alcohol) 1,200 hect. wort have gained an acidity = 4·3 grams H_2SO_4 per litre. The fresh wort contains about two grams per litre and the fermented wort should not exceed a maximum acidity equal to 2·6 grams per litre. Hence: 4·3 − 2·6 = 1·7 grams per litre, or 204 kilos of acid (calculated as H_2SO_4) in 1,200 hect. of wort. Estimating the loss from this cause to amount to four hect. of alcohol, we arrive at a total loss of 10·2 + 4·0 = 14·2 hect. at 100° or 15·8 hect. at 90°, representing at 35 francs per one hectolitre, a sum of 550 francs.

2. Cost of supplementary yeast: 200 kilos, at 10 francs per 100 kilos = 20 francs.

3. Cost of unproductive labour: this loss is variable, let us estimate it at 100 francs.

4. To the above losses which may be easily calculated, there should be added:—

(*a.*) The cost of additional fuel with reference to the work done.

(*b.*) The additional loss of alcohol resulting from the faulty condition of the fermentation since the actual infection up to the day on which it was verified as above. It is certain that the vats which preceded those referred to must also have given inferior returns and that the calculations under 1 (*a*) and (*b*) would also be proportionally applicable. Further, the increased acidity will give rise to a quantity of ethers

during distillation and rectification which injure the flavour of the spirit.

5. Finally, a very serious loss has sometimes to be reckoned with, *i.e.*, the alteration in the roots during the period of diminished working or of actual stoppage. From this special point of view the work, in the present example, may be regarded as completely stopped for three days, under which circumstance an appreciable reduction of sugar in the roots would take place, especially if stored under ordinary conditions, if they survive the rains, the frost, and the thaw, for the roots continue to vegetate, and may freeze or rot if not worked.

[On this subject we may remark that in a large number of distilleries we do not believe that sufficient effort is always made to get through a maximum amount of work. When the fermentation slackens or some serious difficulty hinders rapid progress, the distiller is not much alarmed provided that some progress is made; he temporises, and finishes by becoming almost accustomed to do three-quarters or even two-thirds of the possible work in the 24 hours. He easily puts off the repairs or the necessary alterations until the following campaign, or hopes that before long the sluggish fermentation will revive of its own accord.

It thus happens that, being delayed, either by the fermentation, by an actual accident, or by any chance circumstance such as lack of water, an insufficient number of vats, &c., he has to work for a longer period than he ought, and as the same inconveniences are repeated in every campaign, he easily persuades himself that he cannot work more than an average of 100,000 kilo. of roots, for example, when he is capable of dealing with 120 tons.

It is hardly necessary to remark that if he only produces $\frac{3}{4}$ of the normal work he will have to work four months instead of three, but we shall insist on this fact in order to show that the roots may be greatly deteriorated during these four months, the damage increasing with the imperfections of the method of storage. Have we not seen, even in a favourable campaign, the distillers working as late as March!

And, besides the loss resulting from the disappearance of sugar in the roots, what an increase in the general expenses! The factory has long ago recognised the advantages of short campaigns from every point of view. The more modern usines make an enormous daily output, in order to work for a short period.

We are perfectly aware that the agricultural distilleries are not so perfectly equipped; many of the latter are still working with old-fashioned appliances, but we repeat that the small distilleries furnished to treat 70 to 80 tons barely reach from 50 to 60 tons, whilst it often happens that a slight modification may increase the working capacity in a marked degree. But we here conclude our observations on this topic, and hasten to conclude the subject which now occupies us.]

All things being considered, we may reckon that such a defect as that described above will cost the distiller a cheque for not less than one thousand francs.

In more serious cases, when work has been at half-pressure during eight days, with attenuations varying from 0·3 to 0·6 and a fermentation of corresponding inferiority, ending in a complete stoppage for from three to four days, during which time fresh fermentations are attempted but yield the same results, the acidity of the wort rising to 7 grams per litre, and, when the wort is examined under the microscope, is found to be swarming with the butyric ferment; in such a case it is not only one but several cheques that are lost.

We willingly admit that commonplace accidents in the work may involve a loss of some hundred francs, but in those factories to which we now refer we have never experienced such a disaster; they always worked well with the exception that they did not bother to control the work otherwise than by sight and smell!

We may state that even those distillers who telegraph for us in their difficulties would thus reason eight or ten days before "the disaster;" we might even cite the case of a veteran of the industry who told us in confidence that he had never had a serious accident during 25 years, and that he could not now deviate from bad methods if all his experience was at fault. To such we would simply say as follows:—

"We admit that you have been free from accidents, that your vats do not abate working during the campaign, that the fermentation progresses satisfactorily, even with wort derived from damaged roots; we admit that all you tell us does not concern you in any manner; is that your reason for concluding that chemical control does not interest you?

Apart from the fermentation which, according to your unquestionable experience, cannot go seriously wrong without your perceiving it by the smell, the appearance, or the extent of the attenuation, do you suppose that there are no other causes of loss in your factory except some hectolitres of good alcohol to be recovered?

Let us proceed to the study of the "invisible losses" such as occur even when the fermentation is most satisfactory."

(To be continued.)

The Mauritian crop just finished has reached fully 200,000 tons; but owing to the delay in completing it, the ratoons have been affected so that the outlook next year is not good. The price of sugar is still very unsatisfactory having fallen from Rs. 9·50 last September to Rs. 7·60. Their chief market, India, is being invaded by large shipments of Java sugar. In consequence some firms contemplate making yellow consumption sugars for the British market next crop.

A NEW PROCESS FOR PURIFYING DIFFUSION JUICE WITH A MINIMUM OF LIME.

By M. J. Zamaron.

(*Continued from page 139.*)

Third Series. Diffusion juice with 20 gr. $Al_2O_3nH_2O$ per litre + n lime, heated to 82-85° and filtered. Filtration very good.

	Alkalinity per litre of juice (CaO). Phenol.	Tournesol.
Before filtration	2·00	2·40
After ,,	1·40	1·60
Heating to 75°.		
Before first carbonatation	4·00	4·40
After ,, ,,	0·85	1·00
Heating 70-75°.		
Before second carbonatation	2·20	2·50
Heating 98°.		
After second carbonatation	0·25	0·40

the quantity of lime actually added per litre was therefore 5·95, being 0·6 per cent.

	Original juice.	Juice after.
Density	1050·4	1059·5
Brix (p)	12·60	14·74
Sugar per 100 cc. juice	10·55	13·75
,, 100 gr. ,,	10·04	12·97
Reducing substances per 100 cc. juice	0·34	0·00
,, ,, ,, sugar	3·22	0·00
Quotient of purity	79·6	88·00
Saline quotient	19·50	26·92

Twelve hours' ordinary working up (70 tons of beets). Results of mean samples taken in the factory:—

	Alkalinity per litre juice. Phenol.
Heating 80-85°.	
Before first carbonatation	14·50
After ,, ,,	1·12
Heating 70-75°.	
Before second carbonatation	4·40
After ,, ,,	0·30
Heating 98°.	

Actual quantity of lime added for the clarification was (Ph) 1·778 per cent., an increase of 1·17 per cent. on the alumina process.

	Initial juice.		Second carb. juice, Filtered.
Density	1049·3	....	1044·4
Brix	12·35	....	11·20
Sugar per 100 cc. juice	10·42	....	10·27
,, 100 gr. ,,	9·92	....	9·83
Reducing substances per 100 cc. juice	0·33	....	0·00
,, ,, ,, sugar	3·16	....	0·00
Quotient of purity	80·35	....	87·7
Saline quotient	19·67	....	26·08

The clarification produced by the alumina treatment compared with that obtained by the ordinary process is shown as follows:—

	Quotient of purity.		Saline quotient.
Alumina process	7·4	....	7·42
Ordinary factory process	7·35	....	6·41

We have thus a difference of 1·05 in purity and 1·01 of saline quotient in favour of the alumina treatment.

Finally an attempt was made to see if one could obtain the same clarification as in the preceding trials when carbonating the diffusion juice directly on the addition of alumina and lime after heating *without any preliminary filtration*. The result showed that filtration is necessary before carbonatation in order to achieve all the advantages given by the alumino-lime treatment.

Final Test.

	Alkalinity per litre Juice (CaO).
Heating up 82°.	
Before first carbonatation	4·30 (Ph)
After ,, ,,	1·10
Heating 78°.	
Before second carbonatation	2·80
After ,, ,,	0·25
Heating 98°.	

Actual quantity of lime added per litre = 6·00, being 0·6 per cent.

	Initial Juice.		Second Carb. Juice filtered.
Density	1049·6	..	1052·8
Brix	12·42	..	13·17
Sugar per 100 c.c. juice	10·87	..	12·31
,, ,, gr. ,,	10·36	..	11·70
Reducing substances per 100 c.c. juice	0·21	..	0·00
,, ,, ,, sugar	1·93	..	0·00
Quotient of purity	83·4	..	88·8
Saline quotient	22·16	..	29·12

Giving a clarification of only 5·4 for the purity and 6·96 for the saline quotient. Compared with the treatment with filtration previous to carbonatation, it shows a difference of 2·17 in purity.

	Quotient of Purity.		Saline Quotient.
Mean results of three first tests	7·57	..	8·42
,, ,, last test	5·4	..	6·96

We do not suggest from these experiments that we have effected a commercial possibility. We give the results on the supposition that it were possible to prepare gelatinous alumina ($Al_2O_3\ n\ H_2O$) commercially as we have done in our laboratory, only at a much lower price. The clarifying agent we employed for our experiments was prepared as follows:—

Ordinary alum	200 grammes.
Ammonia	111·84 grammes.
Water	Sufficient for solution.

This gave 1 kg. of gelatinous alumina containing a large proportion of water.

Now supposing the price of alum is 0·25 fr. per kg., and the ammonia 0 fr. ·40; the kg. of alumina such as we prepared would come to about 0·10 fr. in cost.

A factory working up 300 tons of beets per 24 hours would then employ (granting 110 litres of juice per 100 kg. of beets) 6,600 kg. of alumina, which would cost 660 francs.

It would consequently be necessary for the chemical industry to be able to sell gelatinous alumina to the refineries at a price of 1 franc* or less per 100 kg. in order for the foregoing process to be placed on a practicable footing. It is to be hoped that the chemical industry will respond to the need, and that the future will bring about a solution of the problem.—*(Sucrerie Belge.)*

NEWNHAM PADDOX ESTATE, COUNTY OF WARWICK.

Sugar Beet Cultivation in the Year 1903.

This is the fifth year that sugar beet has been grown on the Estate of the Earl of Denbigh at Newnham Paddox, in the County of Warwick, and it is most encouraging to find, that though the weight of the roots grown per acre is somewhat less than in some previous years, yet that the quality is very good, and better than the roots grown in Germany.

In addition to the plot grown on the Home Farm, sugar beet was also cultivated by four of the tenants on the Estate—namely, Mr. James L. Harrison, of Pailton Fields; Mr. William Kenney, of Brockhurst; Mr. J. Parker Toone, of High Cross; and Mr. John Wright, of Kirby Manor.

Lord Denbigh has always arranged that the sugar beet should be grown under the same conditions as mangels, and for the weight of the mangels to be taken at the same time as the sugar beet.

Mr. John Harrison, of Pailton, was good enough to undertake the duty of weighing the roots, and he selected the plots on the 21st of October, and the roots were weighed on the same day.

*This is apparently meant to be "10 fr." *(Ed. I.S.J.)*

The average weight of the sugar beet roots cleaned, and with the tops removed, was 13 tons 3 cwt. 2 qrs. 18 lbs. per acre. The best crop was 16 tons 15 cwt., and the lightest 10 tons 17 cwt.

The mangels cleaned, and without the tops, averaged 32 tons 11 cwt. 1 qr. 20 lbs., and the best crop 44 tons 4 cwt., and the lowest weight was over 27 tons an acre.

There is no doubt that the season was not a favourable one for the sugar beet, and the weights per acre are much less than in previous years.

We have now to consider the analysis of the roots as regards their value for the manufacture of sugar, and Mr. Sigmund Stein, of Liverpool—so well known to all for the time and attention he gives to the sugar beet question—has analysed the roots, and his report is most encouraging.

The seed sown was in all cases the Klein Wanzleben, and Mr. Stein reports that the roots are all most satisfactory, both in saccharine contents and weight, and superior to roots grown in Germany and in every way excellent for manufacturing sugar.

In the following table we only give the results of the analysis of the sugar in the juice and in the roots, and the quotient of purity, as it is from these that the value of the roots for manufacturing purposes are calculated:—

ROOTS GROWN AT NEWNHAM PADDOX.

	Highest.	Lowest.	Average.	GERMAN ROOTS.
Quantity of sugar in 100 parts of the juice......	19·30	16·80	18·34	16·87
Quantity of sugar in 100 parts of the roots......	18·40	16·00	17·44	not given
Quotient of purity......	89·10	87·61	88·49	85·63

The above figures speak for themselves, but it will be worth considering what amount of money could have been realised if roots of the standard grown at Newnham could have been sold to a sugar factory, and from the data of Dr. Carl Stammer we find that the heaviest crop of sugar beet would have been worth £22 16s. 6d. an acre, and the crop with the lowest weight £14 14s. 6d., and the average value per acre is £16 17s. 6d.

There are, of course, many things to be considered, and a most serious one would be the cost of hauling the roots to the sugar factory. Though in America they think very lightly of 50, or even 100 miles, in England we must have a factory within a short distance, and assuming we allow £1 17s. 6d. for the cost of delivery, and the extra cost of cultivation, this will leave £15 an acre, and this must be compared with the value of a crop of mangels for consumption by cattle.

Taking the average of the crop of mangels grown at Newnham as given above, at 32 tons 11 cwt. an acre, what are these worth for consumption on the ground. I have sometimes discussed this with experienced tenant-right valuers, and I have been told that, at times, the value is 10s. or 12s. or even as high as 15s. a ton, but judging from my own experience, if the value was put at 7s. 6d. a ton I think this would be more than is usually made.

The best crop of mangels came to 44 tons an acre, and if the grower was told these were worth £22 an acre, he would ask how it was to be made, and even at 7s. 6d. there might be some difficulty in proving that his cattle had made a profit of £16 10s. an acre.

But the average crop must be taken, and the 32 tons 11 cwt. at 7s. 6d. per ton would be £12 4s. an acre, and if the grower could realise this amount I am sure he would be very well satisfied.

If these calculations are at all right it shows that, grown under exactly the same conditions, it may reasonably be contended that a crop of sugar beet will make £15, as against £12 4s. made by mangels, after making full allowance for the extra cost of cultivation and raising of the sugar beet.

I will only add that the experiments carried on by Lord Denbigh, at Newnham Paddox, were commenced to see if sugar beet could be grown in England of as good quality as in Germany, and during the five years these trials have been made it has always been proved that we can grow roots that show a better analysis than the German ones, and what is now wanted is some capitalist who will start a sugar factory with the best and latest improvements; and I am pleased to hear that arrangements have been made to obtain a large tract of land in Ireland for the growth of sugar beet, and that in a short time we shall hear of sugar being made in that favoured country.

Many people have in the past doubted the possibility of growing good sugar beet in the British Isles in years when there was not much sunshine. It is interesting therefore to note that in 1902 and 1903, which have been nothing like so hot as the three of four preceding years, there have been no material differences in the analysis of the sugar beet grown at Newnham Paddox.

HENRY H. CAVE.

Estate Office, Rugby.

It is somewhat of a novelty to hear of a Leipzig confectioner who is trying to boom East Indian sugar at the expense of his native beet sugar. The American beet sugar papers wax quite indignant at this display of heresy in the very centre of the beet sugar industry.

Correspondence.

CUT SUGAR CANE.

To the Editor of "The International Sugar Journal."

Sir,—I find in one of my Chemical Journals the following statement that may interest many of your readers. It appears that experiments have been recently made to determine the rapidity with which saccharose is converted into glucose after the canes are cut; from these it is seen that the total loss of saccharose (cane sugar) is 2·7 *per cent.* on the first day; 8 *per cent.* on the second day; 21·4 *per cent.* on the third day; and 32 *per cent.* on the fourth day. This shows that in the first two days the loss is relatively small, but after three days, more than one-fifth of the available sugar has disappeared. It is evident from these results that the canes should be received at the factory not later than 24 to 36 hours after they have been cut. The experiments were published in Bulletin of the Imperial Institute last year.

I am, Sir, yours, &c.,

T. L. Phipson, Ph.D.,

Author of "*Observations on the Agricultural Chemistry of the Sugar Cane, &c.*

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. Thompson, C.E., F.C.S., M.I.M.E., Chartered Patent Agent, 6, Lord Street, Liverpool; and 322, High Holborn, London.

ENGLISH.—Application.

4112. E. Shaw, London. *Improvements in the treatment or preparation of sugar and in machinery or apparatus for use therein.* 18th February, 1904.

Abridgment.

5770. A. J. J. Wache, Paris, France, and E. F. G. E. Locoge, Douai (Nord), France. *Apparatus for concentrating liquids.* 12th March, 1903. An apparatus for the circulation and evaporation of liquids composed of a double column, the one for ascending liquid, provided with cocks near the bottom for the introduction of air, and increasing in diameter as it increases in height; the other column of descending liquid provided with a foot valve.

GERMAN.—Abridgments.

148175. Otto Gotsche, Schöningen. *A method of pressing out beetroot shreddings and the like.* November 12th, 1902. The shreddings are first partially freed from water by being pressed. A heating medium, such as steam, hot gas, hot water, or the like, is then

introduced into the mass of shreddings under pressure, so that a uniform heating of the pressed shreddings takes place through the entire mass. The shreddings are afterwards again finally pressed.

147128. OTTO DROZ, Magdeburg. *A beetroot washing apparatus with a mechanism for automatically opening and closing the sludge discharge valves.* 17th December, 1902. The movement of the closing valves is operated by ropes or chains running over guide rollers being attached to weighted levers so that when the cords or chains are pulled, the levers are lifted and thereby the valves opened. When the ropes or chains are not pulled the lids of the sludge discharge valves are pressed by weights against the closing nozzles, so that the discharge valves remain closed. In order to arrange the action of the cords or chains in such a way that they are pulled in regular succession, and at regular periods, and again released, the separate ropes or chains are attached to drawbars which are mounted in the bottom of the framework and adapted to be moved vertically up and down. The drawbars are arranged in a circle in the centre of which a bar which operates them is moved up and down by means of a crank. A cam is mounted on the operating bar which can turn round the bar but not make a vertical movement thereon. This cam is intended to force the separate drawbars to share for a certain time in the vertical movement of the operating bar according as it engages with suitably arranged projections on the separate drawbars. Slide bars are arranged on separate drawbars, which slide bars force the cam to turn in a circle on the operating bar and thus to follow a certain course, *i.e.*, to travel from one drawbar to the next.

147728. HEINRICH JUDENBERG, Braunschweig. *An apparatus for washing beetroot and the like with means for automatically carrying away the sludge.* 22nd February, 1903. The sludge catcher is provided with a mechanism (for instance a worm) adapted to convey the sludge to a collecting place, which mechanism opens from time to time a valve thus discharging the accumulated sludge.

IMPORTS AND EXPORTS OF SUGAR (UNITED KINGDOM.

To end of February, 1903 and 1904.

IMPORTS.

Raw Sugars.	Quantities. 1903.	Quantities. 1904.	Values. 1903.	Values. 1904.
	Cwts.	Cwts.	£	£
Germany	551,609	1,069,557	209,735	455,142
Holland	63,052	59,499	23,738	23,435
Belgium	181,609	38,535	74,122	14,812
France	20,086	12,525	8,646	5,868
Austria-Hungary	717,208	331,311	300,071	156,635
Java	....	188,135	....	83,999
Philippine Islands	....	....	....	....
Peru	31,271	187,840	11,354	82,294
Brazil	30,625	60,146	11,471	23,721
Argentine Republic	53,432	....	23,088	....
Mauritius	651	60,516	320	22,134
British East Indies	43,393	27,551	16,057	11,789
Br. W. Indies, Guiana, &c.	56,934	126,362	37,945	78,792
Other Countries	57,655	50,542	25,032	24,419
Total Raw Sugars	1,807,525	2,212,519	741,579	983,040
Refined Sugars.				
Germany	1,802,689	1,350,208	932,787	743,276
Holland	356,402	474,563	208,146	277,472
Belgium	17,274	48,821	10,244	27,678
France	124,644	226,482	73,174	121,850
Other Countries	192,732	114,932	96,700	60,215
Total Refined Sugars	2,493,741	2,215,006	1,321,051	1,230,491
Molasses	240,553	237,169	48,113	45,932
Total Imports	4,541,819	4,664,694	2,110,743	2,259,463

EXPORTS.

British Refined Sugars.	Cwts.	Cwts.	£	£
Sweden and Norway	3,189	3,631	1,660	2,102
Denmark	13,104	16,368	6,625	8,563
Holland	10,274	9,678	5,577	5,031
Belgium	1,745	2,086	843	1,130
Portugal, Azores, &c.	1,125	1,225	579	776
Italy	1,648	1,091	765	516
Other Countries	61,586	42,388	37,778	27,997
	92,671	76,467	53,827	46,115
Foreign & Colonial Sugars.				
Refined and Candy	3,348	3,511	2,362	2,621
Unrefined	5,906	10,823	3,062	5,756
Molasses	29	25	24	11
Total Exports	101,954	90,826	59,275	54,503

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1904. Tons.		1903. Tons.
Total Receipts, 1st Jan. to March 17th..	382,414	..	300,258
Receipts of Refined ,, ,, ,, ..	25	..	212
Deliveries ,, ,, ,, ..	371,509	..	286,016
Consumption (4 Ports, Exports deducted) since 1st January	321,705	..	267,434
Importers' Stocks (4 Ports) March 16th..	23,066	..	18,627
Total Stocks, March 23rd..	130,000	..	184,777
Stocks in Cuba ,, ...	248,000	..	312,000
	1903.		1902.
Total Consumption for twelve months ..	2,549,643	..	2,566,108

CUBA.

STATEMENT OF EXPORTS AND STOCKS OF SUGAR, 1902 AND 1903.

(Tons of 2,240lbs.)	1903. Tons.		1904. Tons.
Exports	97,309	..	268,503
Stocks	263,779	..	206,718
	361,088	..	475,221
Local Consumption (two months)..	7,730	..	7,950
	368,818		483,171
Stock on 1st January (old crop)	42,530	..	94,835
Receipts at Ports up to Feb. 29th..	326,288	..	388,336

J. GUMA.—F. MEJER.

Havana, February 29th, 1904.

UNITED KINGDOM.

STATEMENT OF IMPORTS, EXPORTS, AND CONSUMPTION FOR TWO MONTHS ENDING FEBRUARY 29TH.

SUGAR.	IMPORTS. 1904. Tons.	1903. Tons.	1902. Tons.	EXPORTS (Foreign). 1904. Tons.	1903. Tons.	1902. Tons.
Refined	110,750	124,687	303,229	175	167	201
Raw	110,626	90,376	217,532	541	295	617
Molasses	11,858	12,027	9,548	1	1	22
Total	233,234	227,090	530,309	717	463	840

	HOME CONSUMPTION. 1904. Tons.	1903. Tons.	1902. Tons.
Refined	121,834	116,562	308,682
Raw	18,423	81,651	238,127
Molasses	14,377	11,234	11,430
Total	154,634	209,447	558,239
Less Exports of British Refined	3,823	4,633	5,781
Home Consumption of Sugar imported from Abroad..	150,811	204,814	552,521
,, ,, ,, Refined (in Bond)	77,424	—	—
,, ,, Molasses, manufactured (in Bond)	10,376	—	—
Total Home Consumption of Sugar	238,611	204,814	552,521

STOCKS OF SUGAR IN EUROPE AT UNEVEN DATES, MARCH 1ST TO 23RD, COMPARED WITH PREVIOUS YEARS.

IN THOUSANDS OF TONS, TO THE NEAREST THOUSAND.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	TOTAL 1904.
84	1322	810	580	298	3095

	1903.	1902.	1901.	1900.
Totals	2981 ..	3141 ..	2483 ..	2298

TWELVE MONTHS' CONSUMPTION OF SUGAR IN EUROPE FOR THREE YEARS, ENDING FEBRUARY 28TH, IN THOUSANDS OF TONS.

(From Licht's Monthly Circular.)

Great Britain.	Germany	France.	Austria.	Holland, Belgium, &c.	Total 1903-4.	Total 1902-3.	Total. 1901-2.
1708	915	617	435	510	4186	3677	4228

ESTIMATED CROP OF BEETROOT SUGAR ON THE CONTINENT OF EUROPE FOR THE CURRENT CAMPAIGN, COMPARED WITH THE ACTUAL CROP OF THE THREE PREVIOUS CAMPAIGNS.

(From Licht's Monthly Circular.)

	1903-1904. Tons.	1902-1903. Tons.	1901-1902. Tons.	1900-1901. Tons.
Germany	1,950,000 ..	1,762,461 ..	2,304,923 ..	1,984,187
Austria	1,175,000 ..	1,057,692 ..	1,301,549 ..	1,094,043
France	780,000 ..	833,210 ..	1,123,533 ..	1,113,893
Russia	1,200,000 ..	1,256,311 ..	1,098,983 ..	918,838
Belgium	210,000 ..	215,000 ..	334,960 ..	333,119
Holland	125,000 ..	102,411 ..	203,172 ..	178,081
Other Countries.	410,000 ..	325,082 ..	393,236 ..	367,919
	5,850,000	5,552,167	6,760,356	5,990,080

A LIGHT-RAILWAY BRIDGE ON A MAURITIUS SUGAR ESTATE.

THE

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☞ The Editor is not responsible for statements or opinions contained in articles which are signed, or the source of which is named.

NOTES AND COMMENTS.

Messrs. Blyth Bros. & Co., Mauritius, report shipments of sugar from August 1st to March 10th, at 132,444 tons, as compared with 96,953 tons for the corresponding period of the previous season. It went chiefly to India, the Cape, and the United Kingdom.

Exports from British Guiana from January 1st to 5th April, 1904:—sugar, 23,906 tons; rum, 793,759 gallons; molasses, 213 casks; molascuit, 1,150 tons; cocoa, 8,809 lbs.; against 31,444 tons, 926,874 gallons; 1,737 casks; 132 tons; and 18,330 lbs. respectively for the like period last year.

The Beet Sugar Movement in the United Kingdom.

The movement to start a Beet Sugar Industry in the United Kingdom continues to make headway, and there have been unofficial reports circulating within the last few weeks as to the nature of the operations. But until the precise details are all complete and we are supplied with reliable information, it would be wiser to refrain from setting before our readers an account of the proposed scheme. In the meanwhile, however, a note of warning may not altogether be out of place. It must not be forgotten that this new industry—new for all practical purposes as far as this country is concerned—will have to compete with an old established and highly specialized industry in Germany and Austria-Hungary. These latter countries which

constitute the chief beet-growing areas of Europe, have by long years of competition with the cane-sugar trade, arrived at such a degree of skill and perfection in their own line, that no natural advantages existing in a certain beet sugar area (such as that of Great Britain is alleged to possess) will make up for any want of knowledge and skill in the various processes of root production and manufacture of sugar. Should this new scheme be undertaken by individuals who have had no previous experience, and having had none, yet refrain from securing the services of a residential expert to supervise operations; or else deem themselves competent after a few preliminary lessons from a "sugar expert"—in any of these cases their endeavours are exceedingly liable to come to grief. It will then be said that this country is not suitable for a beet sugar industry; whereas the real reason of it will be the ignorance of the pioneers in the scheme. It therefore behoves the promoters to ensure a sufficency of skilled overseers to be attached to particular districts; these men may have to be secured from abroad or from the U.S.A., but whatever their origin, there must be plenty of men who have had a previous wide experience in the beet sugar industry.

The *Demerara Chronicle*, in discussing the project to manufacture beet sugar in Great Britain, adopts a pessimistic tone which seems wholly unwarranted by the circumstances. Our contemporary deems that it is only a question of time ere a beet sugar industry, subsidized within the limits of the surtax to the extent of £2 10s. per ton, is in full swing in the United Kingdom, and succeeds in cutting out the West Indies from the home market, all the more since we are debarred by the terms of the Brussels Convention from granting a similar preference to our colonies. But however desirable it might be to start a new agricultural industry by means of such a preference in our own country, one has to bear in mind that such preferences, in the opinion of the majority, come within the sphere of protection, and we have it on the authority of Sir N. Lubbock, whose letter on the interpretation of the *surtax* appears in another column, that there is no chance in the present state of political opinion of any such preference being granted. Then again while it is true that we are debarred by the Convention from granting a preference to Colonial sugar, it must be remembered that the Convention is for five years only, and after that any State a party to it can, on giving notice, withdraw. If, as we hope may come to pass, the cause of tariff reform in this country has made sufficient progress by the time the five years terminate, then there is every reason for believing that no new agreement will be drawn up that does not enable us to grant preference to our own dependencies. Under the circumstances, it may be deemed fairly accurate to suppose that by the time public opinion is ripe for granting preference to home producers, it may be likewise so with regard to Colonial ones. In any case, however bright its

prospects on paper, there is no substantial ground for supposing that the British beet sugar industry will grow by phenomenal leaps and bounds and "cut out the West Indies." There is always a demand for good cane sugar at home, and it is certain to increase largely in the future, so that, other things equal, the home industry will compete rather with the trade in beet sugar from abroad than with the Colonial cane sugar.

Mauritius.

From our Mauritian correspondent we learn that a cyclone passed close to the island in the middle of March, but fortunately did only trifling damage to the crop. The neighbouring island of Bourbon, however, experienced the full force of the hurricane, and there the damage done was very great; 60 per cent. of the crop is estimated to have been ruined and several sugar factories are destroyed; the total damage is variously estimated at from seven million to fifteen million francs. The prospects of the coming Mauritius crop are satisfactory, and a full average return is expected.

The 1904 Budget.

The 1904 Budget just introduced into Parliament does not propose any change in the taxation of sugar; tea is the article of consumption to be touched this time, and a rise of 2d. per lb. in the existing duty is proposed. The subsequent debate brought out Mr. Thomas Lough, M.P., in a new light. Hitherto we have known him as a most determined opponent to granting any aid or preference to the colonies, notably as regards the sugar industry; but surprising to relate, we have him now championing the cause of the colonists, whose tea industry is threatened by the increase in the tax. It is not to be wondered at that Mr. Chamberlain confined his speech to an amusing comment on Mr. Lough's supposed accession to the ranks of the tariff reformers.

The current sugar crop in Barbados is expected to be a good one. Hopes are expressed that it may attain to a total of 60,000 hhds., as compared with 35,000 hhds. last year.

There is said to be a scarcity of labour in Cuba, in consequence of which the harvesting of the sugar crop has been delayed. The immigration law at present in force is responsible for this, as it prevents a strong influx of able labourers into Cuba to till the fields and gather the crops. This drawback has been realised by the Cuban Congress, and a bill is now under consideration for amending the law dealing with immigration.

"SUGARED PRODUCTS."

The first Article of the Brussels Convention declares that all bounties on the production or exportation of sugar are abolished, and that, "for the application of this arrangement, sugared products (*produits sucrés*) such as sweetmeats, chocolate, biscuits, condensed milk, and all other analogous products containing sugar artificially incorporated in considerable proportion, are assimilated to sugar." All bounties on the production or exportation of such sugared products are therefore abolished by the Convention, and it is evidently one of the duties of the Permanent Commission to see that this arrangement is carried out.

It is probable that many delicate questions arise in the course of the onerous duties committed to that body, but surely none more delicate, complicated and involved than this wide subject of sugared products. A direct bounty on sugared products is easily dealt with, but a bounty arising from excessive drawback is not to be detected so promptly. A surtax on sugar which shall be sufficient to protect but insufficient to form a Cartel bounty is a comparatively simple matter; but to devise import duties on sugared products which shall protect the producer in his home market without enabling him to raise his price sufficiently to form an export bounty fund, is evidently a very complicated undertaking. A third and simpler duty is to see that no sugared products are admitted from countries which use bounty-fed sugar in their manufacture.

The surtax is clearly the greatest difficulty. So far as the sugar contained in the sugared product is concerned, the course is simple enough. If the quantity can be estimated the surtax would naturally be limited to the rate laid down in the Convention. But there are other ingredients, and they must be dealt with on the same principle if the stipulations of the Convention are to be carried out. This at once opens a wide field of enquiry. Duties which will be just sufficient to protect and no more will have to be discovered for a great variety of products. The investigation will be not only interesting but useful. It will, in fact, be a continuation of the process of tariff reform which the Sugar Convention has had the honour of originating. "Dumping," properly so called, is only possible when import duties are so much above the point necessary for mere protection that they enable the producer to make large artificial profits and thus form an export bounty fund. That has been stopped as regards sugar by the Brussels Convention, and now it will be stopped by the same means as regards all the ingredients of sugared products. It is a large order, and we trust that the Permanent Commission will rise to the occasion and discharge their duties in a workmanlike manner.

THE BRUSSELS SUGAR CONVENTION.

Under the above title Mr. George Martineau, C.B., contributes an interesting and instructive article to the *Economic Journal* (Macmillan) which is well worth reading by all those interested in the subject. As he is writing for a class of readers, whose acquaintance with the rise and progress of the bounty system can hardly be of an extensive character, he might be pardoned for offering some of the old time-honoured arguments, which, if they remain as true as ever to-day, are nevertheless too familiar to attract further interest from those associated with the sugar industry. Yet, although we have ourselves had so many like contributions from his pen, this last one lacks nothing in originality of treatment; many of the facts given will be scarcely known to any but those who have followed very closely the course of events the last 40 years.

Mr. Martineau begins with a brief historical retrospect of the various events that led up to the present Brussels Convention, and the previous diplomatic failures which occurred at periodic intervals.

Apparently it was Mr. Gladstone who, in this country, first considered the advisability of an international abolition of bounties. We are told that in 1864 he took up the subject with a light heart, little dreaming that nearly 40 years would elapse before the sugar bounty question would be finally settled. The 1864 Convention was the result of his policy; this contained a clause recognising the necessity for some penalty against any infringement of its provisions. This Convention Mr. Gladstone declared to be "a beneficial arrangement, beneficial alike to importers, refiners, and consumers." We only wish the Gladstonian politicians of the present day, especially one representing a North London constituency, would bear in mind that Gladstone, of all other men, in the light of his 1864 policy would have approved rather than disapproved of the 1902 Convention.

The 1864 Convention lasted ten years; and during that time France evaded her engagements, as far as the bounty granted to the Paris refiners was concerned (just as now she seems inclined to evade where possible the spirit of the 1902 Convention); this bounty went on steadily increasing, and the climax seems to have been reached in 1872 when a struggle began at the instigation of the British refiners, they being subsequently joined by the French *fabricants* who suffered under the same anomalies. The crux of the matter was that under the existing arrangements the French refiners (mainly a few large firms in Paris) paid duty on the raw sugar entering into their establishments, and getting a drawback on the refined sugar exported, secured a bounty owing to differences in the estimated yield. The only effectual remedy was to levy no duty till the sugar went out into consumption. "By that means the refined sugar which went for

export, having paid no duty, would receive no drawback and therefore no bounty." This plan involved "refining in bond." Our own Government was convinced that this remedy was the only efficacious one, but it was difficult to get the French Government to move. The Paris refiners were so rich and powerful, that although the National Assembly were induced to vote for refining in bond, delays in the international negotiations enabled this vote to be quashed.

The 1864 Convention was rendered abortive mainly through the obstinacy of France. The 1877 Convention, on the other hand, was wrecked through the refusal of the British Government to give the security required by the other States, that if the latter abolished bounties they would not have to encounter competition from bounties in other quarters. In short, the question of countervailing duties, here first seriously advanced, was met with a weak *non possumus* on the part of our Government. It was the old story of a fear lest the immaculate conception of Cobdenism should thereby be tampered with. The 1877 Convention consequently came to nothing.

Mr. Martineau next proceeds to trace the rise and expansion of the German and Austrian bounty systems, which began to attract notice about this period. He shows that what was originally started as a natural attempt to foster a new industry in those countries and place it on a scientific basis, eventually produced some other far-reaching results. An inevitable one was that more sugar was produced than was estimated; a bounty was consequently obtained out of the drawbacks on export, and the glutting of the markets began.

With the appearance of these new and alarming features, the agitation against bounties was naturally not altogether allowed to drop. In 1879, a Select Committee of the House of Commons, under the presidency of Mr. Ritchie, declared that the imposition of a duty to countervail a bounty *was* consistent with free trade. But as the law officers of the Crown thought otherwise, and declared that it would be an infringement of the most-favoured-nation clause, the Committee's report got shelved and forgotten.

Mr. Gladstone, coming into power once more, had the opportunity of repeating his earlier attempts in the cause of fair trade, but apparently he preferred instead to sacrifice such a thorny question to the political exigencies of the day. At all events he transferred the conduct of the negotiations from the Foreign Office to the Board of Trade, which latter department, openly hostile to the proposed changes, did its best to suppress them.

Ten years passed, and then the urgency of the matter was brought to the notice of Lord Salisbury's Government, who made a weak and half-hearted attempt to pass a bill through the House of Commons; a small minority offered an unreasonable and erroneous opposition, whereupon the bill was promptly withdrawn. This involved ten years' more inactivity.

Apparently the present Government, when the question was placed before them in 1898, were more favourable to the abolition of bounties, but in the absence of an authoritative mandate, they appeared unable to summon up enough courage to take the bull by the horns. Two years later, in the opinion of Mr. Martineau, the mandate was forthcoming, in the shape of a resolution passed by a large majority at the Congress of Chambers of Commerce of the Empire, held in London, declaring in favour of a Convention with a penal clause. The ice was now broken, and the way was paved for the subsequent successful negotiations and Convention.

Here Mr. Martineau takes the opportunity to explain in brief the nature of a more dangerous form of bounty which has risen within the last few years. He refers to the Cartel bounties, which he has so often described and exposed in our columns. It appears though that this system originated in Russia, where it was under direct Government support; while the German and Austrian industries, who followed the example set them by Russia, were private combinations of the beetroot sugar manufacturers, who took advantage of the high "surtax" existing in their respective countries to raise prices at home and undercut their competitors in outside markets. We know what effect these Cartels had on the imports of French sugar into the United Kingdom; the latter all but ceased for six months or so at the beginning of last year.

The Austrian Cartel obtained more than 9s. per cwt. of sugar consumed, and provided an annual Cartel fund sufficient to allow a bounty of 4s. 8d. per cwt. of refined exported. The German Cartel secured nearly 8s. per cwt. of sugar consumed, sufficient to furnish a bounty on exported refined of 5s. 5d. per cwt.

Mr. Martineau then goes on to discuss the definitions in Article I. of the Convention, which undertakes to suppress direct or indirect bounties and proceeds to define some instances of the way in which such advantages may result from State legislation. These are classified under sub-divisions.

Definition (*f*), "Advantages derived from any surtax in excess of the rate fixed by Article III.," was, we are told, inserted at the instance of the British Delegates, in order to put a stop to the Cartel bounties. Indeed, the Delegates wished to define Cartel bounties as advantages derived from *any* surtax, but had to accept some limitation, which legalised a surtax not exceeding 2s. 6d. per cwt.

"These then are the salient points of the Convention. The decision to abolish all bounties; the establishing of manufacturing and refining 'in bond'; the limitation of the surtax; and the security of the contracting Powers that bounty-fed sugar will no longer be tolerated in their respective territories."

One would naturally not expect this article to conclude without some explanation of the present *status quo* in the sugar market, where

prices still seem so low, and expressions of disappointment are coming in from far off cane sugar lands as to the very low prices still ruling with them. Some of these countries seemed to think that the Convention had only to come into force for prices to promptly go up to the natural price (about 9s. per cwt.). They did not take into account the fact of the world's market being glutted with bountied sugars, and the appreciable time that would be required to work them off. This process is in course of accomplishment and ere very long the influence of the old bounties on stocks should speedily fade away. Then prices will range round the cost of production, which means that extraordinary fluctuations need no longer be looked for.

As to the prospects of the cane sugar producers, Mr. Martineau writes in no uncertain tone. "The cane sugar producers will undoubtedly have a great revival. They wanted security—a fair field and no favour—and could not get it. Now that it has at last been given to them they will no longer hesitate to invest capital in their industry. They can, with good appliances, produce a great deal more sugar per acre than their European competitors. There is, therefore, every prospect of their reducing still further their cost of production, which already stands 1s. per cwt. below that of Europe."

In concluding his interesting article, Mr. Martineau makes some comments on the strange decision of the British Government to prohibit the importation of bountied sugar rather than to countervail it. Their idea seems to be that a duty may not be in accordance with the principles of free trade, whereas prohibition is. But Mr. Martineau very accurately points out that the countervailing duty is levied on the bounty, not on the sugar. The bounty is accepted for the benefit of the whole nation of taxpayers and is put in the Treasury; the sugar is then left to compete with all other sugar on equal terms. "Therefore under a system of countervailing duties we do not lose the benefit of the bounty, we do no injustice to the bounty-fed producer, and we save the consumer from the danger to his interests arising from the effect of bounties in discouraging and eventually destroying his natural sources of supply."

"But none of these arguments can be used in favour of prohibition. The sugar is simply shut out and has to find other markets where it will be sold for what it will fetch and will create the same injury to the consumer by discouraging and reducing the natural sources of supply as if it were admitted free into this country. The British producer will therefore suffer the same injury, and the British consumer will be deprived of the sugar." And, it might be added, the British Exchequer will be robbed of the amount of the countervailing duty.

SCIENCE IN SUGAR PRODUCTION.

By T. H. P. Heriot, F.C.S.

(*Continued from page 165.*)

2. The Improved Raw Material.

(*b*) The valued character is inherited from a selected pedigree.

A cultivated plant is not merely the product of field-culture, but also of hereditary laws, so that the selection of the seed, or other planting material, affords another opportunity for improving the stock.

In order to grasp the significance of our present study, we should first point out that Nature never produces a facsimile. Between parent and offspring there is a certain range of variability which is of great importance for the following reasons.

In the animal and vegetable kingdoms we find a possible rate of increase vastly in excess of the earth's capacity to support life. Consequently, only a small minority live to propagate their kind, and these few are the fittest which survive the "struggle for existence." In this universal competition trifling advantages may ensure the life of the individual; the weaker or less fit are destroyed, and the surviving minority are those best adapted to their surroundings, and able to transmit their peculiar advantages to their offspring.

Nature's methods are tentative; her modifications may, or may not, be useful to the individual. She submits them to the test of future generations, in which the useful qualities will invariably be retained, whilst the indifferent or harmful become extinct. This sifting process has been termed "Natural Selection."

Man, as a student of Nature, observes that like generally begets like, and can therefore propagate such of Nature's varieties as appear to him useful or beautiful. "Artificial Selection" then determines what varieties shall be preserved, and the art of the breeder consists in detecting minute differences between parent and offspring, and in fixing and developing such differences by breeding from carefully selected individuals through a long series of generations. He is guided in his choice by commercial interests, love of sport, æsthetic tastes, &c.; his pedigreed animals and cultivated plants bear evidence of his skill and perseverance.

As a rule, the breeder seeks to develop such visible qualities as size, shape, or colour, but in a few cases the valued character is less apparent. Thus, in the saccharine richness of the cane and beet, the cultivator must appeal to science to determine which individuals should be selected as stock for perpetuating the desired quality.

Special methods in the field having evolved a valuable saccharine plant from a very inferior stock, the next step in scientific beet culture was to fix the newly acquired characters in future crops. The sugar beet being, in a sense, an abnormal variety, the tendency of the seedling was to revert, or degenerate, to the old and inferior qualities of the forage plant. Hence the importance of selecting the seed from those beets which contained the highest percentage of sugar, and of rejecting all seed yielded by inferior specimens. But, although a rich "beet-mother" will reproduce rich seedling beets the latter are not all of equal value; some being richer, and others poorer than the parent-root. Consequently, by always selecting the richest beets for seed-production the saccharine value of successive crops has been gradually raised to the present high level in such a manner that we may state that the "improved beet" of to-day is the joint product of field-culture and seed-selection.

Referring to page 110 it will be noted that the sugar beet does not, under normal conditions, produce seed until the second year. To prevent destruction by the winter frosts, the beets intended for seed are removed from the field at harvest, and carefully preserved for replanting the following year.

Science discovered that the richest roots, and therefore those best adapted to serve as beet-mothers, were more deeply embedded in the soil, of more regular shape, and of greater density, than the poorer varieties. These observations were therefore the first guides to Artificial Selection. Books and pamphlets were freely circulated among the beet farmers, instructing them in the selection of the richest roots for seed-production by observing their habits of growth, and finally selecting only those roots which sink when plunged into brine of $3^{\circ}\cdot5$ density. The densest roots were to be carefully preserved through the winter in silos, and replanted in good soil in the following spring, when the roots would throw out new foliage, blossom, and eventually bear seed. The latter was to be collected in the autumn.

These simple observations and tests were admirably adapted for the farmer, but were not of sufficient accuracy for the scientist and sugar manufacturer, because the apparent density of the roots might be largely due to saline impurities and not to sugar. In process of time the test was abandoned, and the roots—selected by their appearance in the field—are now sent to the chemist's laboratory to be individually tested for richness in sugar. This is effected by removing only a small portion of each root sufficient for the analysis, and without injury to the future life of the root when replanted. Roots which show the highest percentage of sugar are preserved as beet-mothers, and all inferior roots rejected for this purpose, and sent to the factory.

Seed selection soon became a distinct industry. Vast laboratories have been built, with steam power for driving the special machinery

for sampling the roots. The methods of analysing the root have also been brought to such a degree of accuracy combined with speed that a chemical staff of seventeen persons can analyse ten thousand roots per day. These wonderful establishments supply beet-seed to all parts of the world, and great reliance can be placed on the high quality of the supply. The large usines generally supply their cultivators with seed which has been similarly tested by "chemical selection" in the large laboratories attached to the factories.

The initial extension of the industry throughout the continent made it imperative to study the effects of climate and soil on the improved beet, and to acclimatise the plant to different districts and countries. Systematic selection in the laboratory, continued year by year, has now evolved many varieties, each of which is specially adapted to local conditions of soil and climate.

The sugar-beet is the product of a century of scientific culture, and it would be rash to assume that it has even now attained its final degree of perfection. We have already stated that field-culture offers scope for further improvement should future fiscal conditions render it practicable.

The Cane.

The propagation of the cane from cuttings, which has so far proved the only practical method of reproduction, has not yet supplied the planter with a richer cane. Hope was entertained in some quarters that the cane would benefit by the same methods of selection adopted for the beet when, in 1893, an expert in Louisiana claimed to have raised sweeter canes from cuttings or tops selected from rich parents. Unfortunately for the cane industry his conclusions were not based on sufficient evidence, and have been entirely negatived by experiments extending over three years at the Barbados Experimental Station. Experts now conclude that canes raised from cuttings inherit the characters of the ancestral stock rather than those of the parent cane from which the cuttings are obtained.

It is still an open question whether the cane produces bud-varieties, that is to say, abnormal canes springing from stools of well known varieties; but this occurrence is probably extremely rare, and the search for a sweeter sport-cane has consequently been abandoned. Attempts to produce an hybrid cane by the familiar method of grafting have also proved valueless.

Until within the last two or three years the only choice offered to the planter was in the cultivation of varieties imported from other cane-growing countries. The systematic examination and comparison of these varieties was not undertaken until 1888, when Government experts, attached to the West Indian Colonies, came to the assistance of the industry.

Our historical notes sufficiently indicated the variety of climates and soils in which the cane has been cultivated, and these frequent

changes of habitat have given rise to some 40 different varieties of canes which are to-day known and classified. The following opinions* of a Java expert in the fifties have been fully confirmed by recent researches :—

"1. That every (sugar cane) region is peculiarly adapted to the culture of one or other variety of cane, the causes of which science cannot accurately determine.

"2. That we shall be led to false conclusions if we judge of the qualities of a variety of cane, suited to a certain district, by the qualities shown by the same cane when transplanted into conditions of inferior culture.

"3. That the sugar cane, like a great number of other vegetables, is improved by continuous cultivation.

"4. That it is not always advantageous, and that it may be imprudent to replace on a large scale, in a given locality, a good variety of cane by another variety which gives better results in a different region."

We may therefore conclude that although man has been the agent in transplanting the cane from one country to another, other agencies, working through natural selection have given rise to the above mentioned varieties and have adapted each to local conditions. After ten years' experimental cultivation at the Botanic Gardens of Demerara, Professor Harrison came to the conclusion that no known variety exceeds the average yield of the "Bourbon," but that the "White Transparent," which is very slightly inferior in this respect, is a much hardier cane and might therefore replace the "Bourbon" on certain soils.

It is a remarkable fact that the possibility of raising cane from seed was not known, or else discredited in the West Indies about 16 years ago, although seedling canes had been long known in the East. Having, therefore, failed to enrich the older varieties of cane by selective methods of breeding, scientists have more recently turned their attention to the cane seed and the rearing of seedling canes.

Changed conditions of life are powerful factors in causing variation and it seems probable that so vital a change as the method of reproduction may account for the extraordinary variability of the seedling cane which resembles a true "sport." The fact that the saccharine richness of the parent cane, or even of the parent stock, is not inherited by the seedling renders it impossible to pursue those methodical methods of selection employed in the beet industry. But in this tendency to excessive variation lies the hope of finding one or more strongly marked variations in the desired direction; hence, the persevering search during the past 15 years for a seedling of higher saccharine value than any known variety of cane.

*From the *Sugar Cane*, August, 1897.

It will be evident that the cane seed, as a means of propagation, would be very uncertain, were it not otherwise inpracticable. But, as a starting point for the perpetuation of improved qualities by the customary method of planting, a rich seedling cane would be a valuable discovery.

To select from among many thousands of seedlings those few individuals which have spontaneously varied in the desired direction is a task which only scientific method could attempt or bring to a successful issue.

This important work was commenced in 1889 by Harrison and Bovell, at Dodd's Experimental Station, Barbados, and has since been actively followed up by other experts.

The discovery of a valuable seedling necessitates three series of experiments :—

1. The small plot, for the preliminary sorting.
2. The large plot, for the analytical study of the cane.
3. The Estate field for the final test under ordinary working conditions.

The cane industry is indebted to Government chemists and botanists for the laborious work entailed by the two preliminary stages of the research. Their results, published in the official reports and reproduced in this journal from time to time, are only provisional and of little practical value to the planter. To illustrate this point we reproduce some interesting data drawn up by Howard* from which it is seen that the yields in sugar per acre obtained at the Botanic Gardens tend to be much higher than when the same canes are grown under ordinary field conditions.

TONS SACCHAROSE IN THE JUICE PER ACRE.

Canes.	Estate.	Bot. Gardens.
Bourbon	2·61	2·28
625	3·50	5·65
95	2·72	2·56
145	2·48	4·94
74	2·48	4·23
147 B.	2·40	5·64
109	2·42	4·06
78	1·70	2·62
Average =	2·54	4·00 (or 1½ tons in excess).

These increased yields from the experimental plots may perhaps be accounted for by the excess of light and air, and the more efficient weeding which such small plots must receive; also to the perfect maturity of the cane when reaped and analysed. These small plot experiments, however misleading to the planter, are unavoidable, and should be regarded merely as a method of sifting the valueless seedlings from those of more or less promise.

* "Sugar Cane Experiments at British Guiana."—*I.S.J.*, Vol. V., p. 246.

Many thousands are annually germinated in British Guiana alone, whilst the same work is being followed up in Barbados and Trinidad. Thus, in the former colony, 313,000 seedlings were raised from 1896 to 1901, but of these only 19,000—or about six per cent.—showed sufficient promise for further trial. The large majority of the latter have on more critical examination proved inferior sugar producers, and, finally, only some two dozen seedlings are recommended for experimental cultivation by the planters.

Prof. Harrison draws the following general conclusions* as to the characters of seedling canes :—

"1. It is not possible to form an opinion as to the probable richness of the seedling progeny from the richness of the parent cane. This is applicable not only to the actual seedling but to canes propagated from it by cuttings.

"2. In the majority of canes the saccharine richness of the parent variety appears not to be transmitted either to the actual seedlings or to canes propagated from them by cuttings. But in the cases of a few varieties there has been found a tendency for the seedlings to approximate to the sugar contents of the parent kind.

"3. Similar conclusions hold good with regard to the percentage of non-sugars (gums) present in the juice. The glucose-contents, and therefore the glucose-ratio and, in part, the quotient of purity, are governed by the relative degree of maturity of the canes examined and analysed.

"4. Except in some of the more inferior kinds, among both the old varieties and seedling varieties, the size of the individual cane from which the seed is taken apparently in no way affects the size of its offspring, but there is no doubt, as has been repeatedly shown during the experiments, that the average size of the parent variety, with occasional conspicuous exceptions, closely governs the size of its offspring.

"5. Experience has not altogether confirmed the earlier experience with canes obtained from the seeds of seedling canes. Although the majority of the seedlings obtained from the seed of the seedling varieties shows deterioration, some have been obtained of considerable promise.

"6. The fertility of seeds obtained from seedlings is far greater than it is in those obtained from the majority of kinds of the older canes.

"7. While the seedlings of the older varieties with but few exceptions show marked tendency to variation, the seeds obtained from seedling varieties do not possess this property to anything like the same extent, and in many of them the offspring appears to come fairly true to parentage; this is especially the case among those we have studied with No. 95 and 74.

* "Report on the agricultural work at the Botanic Gardens and the Government Laboratory for the years 1896-1902."

"8. The range of variation among the seedlings is far greater in those obtained from parents which are striped than amongst those derived from self-coloured canes, and this is so with regard to colour, size, and sugar contents."

The final and crucial tests must be made by the planting community, and are now in progress. The general opinion of the planters appears to be that some of the seedlings do well on old lands where the Bourbon gives very inferior returns, and the Demerara "Argosy" makes the following statement:—"There are about 7,500 acres under seedling cane cultivation, and so far it cannot be said that any seedling cane has been grown which in all round good qualities is equal to the Bourbon."

We must therefore refrain from drawing any conclusions at present as to the results of incomplete experiments, but, before concluding this paper we would enquire: Is the Industry competent to investigate this subject?

We think not. The average planter and overseer are not experimenters, and have many other duties to attend to. Very few estates have even one resident chemist, and he is generally tied down to routine analyses of the factory products. Attempts to carry out large scale experiments without an adequate scientific staff are hopeless, and had better be abandoned at the outset.

We do not deny that experiments have been, and are now being, made under these adverse conditions, but an examination of the data so obtained generally indicates that time and paper have been wasted. Nothing is easier than to collect incorrect data; few things more difficult than to obtain one accurate and reliable figure. Inaccurate statistics may have an imposing appearance, but besides being worthless they may be seriously misleading. For example, an inferior seedling shows a splendid return of sugar per acre, owing to some miscalculation or a faulty method of experiment. The statistics are believed and acted upon by the proprietors, and a large acreage planted with disastrous results. This will probably be attributed to an unfavourable season until repeated failures prove the former data unreliable.

The first point to be decided is whether any of the seedlings recommended by the Government experts are of sufficient promise to warrant the expenditure of time and money necessary to test its commercial value. Assuming this to be so, the next step will be to engage a scientific staff to arrange and carry out the experiments. Such work would involve:—

1. The chemical analysis of the soils selected for the experiments, and a suitable application of manures to ensure a fair standard of fertility, and to thus minimise the errors due to differences of soil.

2. We would advise large plot experiments before attempting the actual field trials for the following reasons:—

(a.) To obtain an ample supply of good tops.

(b.) To determine the actual weight of canes when this might be impossible on a large scale.

(c.) To determine the best method of sampling the cane in the field.

(d.) To ascertain the age of maturity by analysing average samples of cane at fixed intervals.

(e.) To observe the resistant power of the seedling to disease and attacks of insects.

(f.) To ascertain the saccharine value of the crop by milling average samples in a powerful hand-mill; weighing the juice and megass; analysing each, and calculating the results back to the original cane.

(g.) To obtain an approximate idea of the fuel value of the megass, by noting its physical qualities and determining the percentage of fibre.

The experimental plot should be accurately marked out in the centre of the selected field, and surrounded by the "Bourbon" or other staple variety planted in the same manner on the same date, so as to ensure normal conditions as regards access to light and air. The weeding and trashing of the entire field would be carried out in the usual manner.

The above observations (*b* to *g*) should be made on an equal area of the adjacent "Bourbon" variety for direct comparison with the seedling. Such plot experiments would be entirely independent of the factory mills; they would be of a more practical nature than experiments at the Botanic Gardens, and would give a fair indication of what yields might be expected from a large area.

3. The actual field experiment would involve:—

(a.) The selection of good tops, and supervision of the planting of at least ten acres of the same field.

(b.) Analyses of samples of canes at fixed intervals in order to determine age of maturity, in confirmation of (*d*) for the plot experiment.

(c.) The supervision of the reaping, transport, and weighing of the cane, or, where the cane is not weighed, of the measurement of juice and weighing of the megass.

(d.) The control of the factory to enable the entire experimental crop to be separately milled; the yield of juice observed, and the actual yield of commercial sugar determined.

(e.) Analyses of samples of juice and megass representing the whole acreage ground.

(f.) An experimental "run" of one steam boiler to determine the fuel value of the megass.

Unless the whole acreage of cane under experiment can be separately ground and worked up to dry sugar, we are of opinion that the field experiments should not be attempted: the main object of such being

to determine the manufacturing yield, and the all-round suitability of the cane and juice for treatment in the factory. We have no faith in calculating the commercial yield by assuming any given extraction on the sugar present in the juice, because such factors entirely ignore the relative purity of the juice, and the influence of certain impurities on the final yield of sugar.

The fuel value of the megass is a most important consideration in judging the qualities of a cane, and can only be ascertained by actual trial as proposed under (*f*).

We learn that estates factories have experienced considerable trouble owing to the inferior quality of the megass when milling certain varieties of seedling canes, which necessitates the latter being ground along with other cane in order to keep up the steam pressure. Surely such inferiority is sufficient to condemn any seedling offhand, unless there is good reason for believing that the increased yield of sugar will cover the cost of additional fuel, which is highly improbable. The analyses of the canes from the "estate plot" should enable such inferior qualities in the seedling to be recognised, or at least, indicated before the final test on a large scale is attempted: time and trouble would thus be saved.

The work, as indicated in the foregoing scheme, would be largely of a chemical nature, requiring a staff of at least three chemists in a well equipped laboratory. Previous experience of the cane industry would not be essential as their work would be confined to the analyses. A competent sugar chemist, with practical experience of the cane, would arrange and supervise the experiments in the field and factory. He would require the assistance of an overseer in the field in addition to his chemical staff.

But we fear that few proprietors would appreciate such an increase to their staff when, as at the present day, one resident chemist is generally considered superfluous. Admitting the financial difficulty, we suggest that the industry should co-operate in furnishing the staff for conducting the experiments in a thoroughly scientific manner. Reliable data obtained on one estate only would be of greater value to the industry at large than the conflicting and uncertain results obtained by the misdirected efforts of the individual planter. Such a staff could, in course of time, carry out experiments in the various West Indian colonies on such estates as co-operate in the research.

(To be continued.)

Cane farming in Natal seems to be on the decline, owing, it is said, to there being no satisfactory arrangement as to the basis on which the planters are to be paid for the canes. As everywhere else small cane farming is proving a success, it is a pity that Natal should prove an exception to the rule.

DUTY FREE SUGAR FOR INDUSTRIAL PURPOSES.

By SIGMUND STEIN, Sugar Expert, Liverpool.

There is at present a great agitation going on in Germany, France, and Austria to obtain the use of duty-free sugar for industrial purposes. The production of sugar, either beet or cane, is increasing from day to day. The consumption of the sugar cannot keep pace with the production, therefore the question has arisen as to how sugar can be utilized in other directions, besides as human food. After the Continental States had granted the free use of sugar and syrup as cattle food, the British Government last year acceded to the request to allow syrup or molasses, which are used as cattle food, to be exempt from any duty whatever.

There are other fields, and very large ones too, where sugar could be used in large quantities if the Excise and Customs authorities would allow it to be used duty free; such industries as the textile industries, paper industries, and soap manufactories. As far as I can recollect, the Austrian and Hungarian Governments have been the very first to allow (18 months ago) the free use of glucose, after it had been denatured, to be used in the above named industries. Of course, a few restrictions had to be made by these two Governments, viz.:—(1) That a special licence be required for the purpose, (2) that the manufacturer use at least ten tons of sugar per annum. If any misuse of these facilities was detected, the manufacturer would lose the licence. The process of denaturing is a very simple one. The manufacturer has simply to make an application to the Excise Authorities two days before he wishes to use duty-free sugar. The denaturing is then carried out with chloride of magnesia, and this process must be completed according to the instructions, and in the presence of, the Excise Authorities, and the mixture must be at once used up. Naturally a heavy penalty is imposed on manufacturers, merchants, or agents who should try to extract the chloride of magnesia again, and so evolve a sugar which could be used as human food.

Similar arrangements could be made in this country and large quantities of sugar would find their way into the industries. The question of so using surplus sugar is a very important one for the British sugar industry. First of all, not only white sugar could be used, but sugar-house after products could be utilized. The formation of a British beet sugar industry is getting nearer to an accomplished fact, and therefore there is no reason why sugar which is home produced should not be as well utilized for industrial purposes as for consumption. The British authorities would simply have to work on lines similar to those already existing in Continental countries. For using sugar in particular trades, the best denaturing mediums

can easily be found and by strict supervision any fraud could be prevented.

A great use is made of sugar in the manufacture of soap. About two or three years ago, a Saxony soap works asked the local authorities to allow them to use duty free sugar for soap making; and they got the right, subject to certain conditions, to use white sugar duty free for making transparent soap. The sugar had to be kept in a closed warehouse, of which the keys were in the possession of the authorities. If the sugar is to be used for soap making, it has to be mixed with soap in the proportion of three cwts. of sugar to one ton of liquid soap, and kept for half an hour at a temperature of 165°F. If this is done there would be no possibility that the sugar could be utilized again for human food.

A great quantity of sugar could be used in the leather trade. As the matter stands at present it is impossible to use great quantities in this industry, on account of the heavy taxation. The best way to remedy this would be for those trades which desire to use duty free sugar to make application to the Excise and Customs authorities, and no doubt the latter after careful investigation might find it convenient to allow duty free sugar to be allocated to them. The revenue would lose nothing because the sugar tax in this country is simply a consumption tax, and if a certain quantity of sugar were to be used in certain other trades, such sugar would have to be replaced by further imported or home manufactured sugar.

ON THE QUANTITY OF UNFERMENTABLE SUGAR PRESENT IN CANE MOLASSES.*

By H. Pellet and G. Meunier.

For some years past, considerable attention has been paid to the important question regarding the nature of the reducing sugars existing in cane molasses, and their value from the point of view of fermentation, *i.e.*, for the production of alcohol.

From a certain number of experiments, either in the laboratory or in the course of daily practice, it appeared that the greater part of the reducing sugar contained in cane molasses ferments and yields alcohol.

But, on the other hand, on analysing the wash after fermentation one always found a certain amount of reducing matter that had escaped fermentation and the proportion of which varied. To begin with, the molasses of cane factories is itself subject to large variations in composition; whereas in certain factories molasses is produced having 25 or 30% of reducing sugar, and 30 to 25% of

*Read at Berlin Congress, 1903.

crystallisable sugar, in other factories molasses occur having 40 to 45% of crystallisable sugar and 15 to 10% only of reducing sugar. These proportions depend

1. On the quality of the cane.
2. On the method of working up.
3. On the process adopted for purification of juice, &c.

It may be asked what is the nature of the reducing sugars existing in cane molasses? It is at any rate known that they are formed chiefly of dextrose and levulose together with a trace of either mannose or "glutose."* The following for example is an analysis of Egyptian cane molasses.

Dry matter	73·28
Water	26·72
Crystallisable sugar	36·40
Dextrose	6·10
Levulose	8·48
"Glutose"	2·40
Mannose	0·20
Mineral matter (not CO_2)	8·40
Organic matter	11·30
	100·00

Hence we find 2 to 3% of reducing matter other than dextrose or levulose present in the cane molasses. We must bear in mind that the "glutose" has half the reducing power of invert sugar on copper solution, and that it is entirely unfermentable; whereas mannose has the same reducing power as invert sugar and is completely fermentable. One can therefore state *a priori* that "glutose" is the only one to be considered. It exists as 2·40% of the molasses but as it reduces Fehling's liquor by one-half, one finds by analysis only 1·20 as non-fermentable matter. This is the minimum amount present. In a word, it may be stated that the fermented wash of cane molasses contains all the "glutose" existing in the molasses and which will be represented by one-half its weight in reducing sugar.

Let us, however, see what occurs in practice:—

	Per cent.
Taking a type of molasses corresponding to crystallisable sugar	41
Reducing sugar calculated in crystallisable sugar	13
	54

After fermentation under fairly good conditions, one finds in the lees a certain quantity of reducing matter, amounting to 5, 6 or 8 grammes per litre; whence a loss of from 2·2 to 3·5 of reducing

* The term "glutose" employed by the authors is not familiar in the technology of cane sugar.—(Ed. *I.S.J.*)

sugar per 100 grammes of molasses. In a beet distillery, on the other hand, the quantity of reducing matter found after fermentation is feeble and amounts to practically nothing under well conducted working. Cane molasses contains an appreciable quantity of non-fermentable reducing matter which in practice corresponds to an average of three per cent. of the molasses, when the reducing matter is determined in a special manner.

The determination of the amount of reducing sugar after fermentation presents some difficulties. This is done by means of the copper test, weighing the precipitate of copper oxide and following all the necessary indications mentioned by one of us in order to obtain exact and comparative results.

But we doubt whether the estimation carried out directly on the fermented liquid furnishes the total of non-fermentable sugar, and whether there does not remain either crystallisable sugar or another substance transformed into a reducing agent by the hydrochloric acid.

After several tests we found, in fact, that the amount of reducing matter after inversion was always higher than before inversion. But on the other hand, it was discovered that the difference appeared to decrease in proportion as the quantity of reducing matter also diminished before inversion.

Thus after certain tests which indicated not more than 2 to 2·2 of non-fermentable sugar before inversion we found practically the same result after inversion, yet when we found 3 or 3·5 of non-fermentable reducing sugar before inversion (per 100 gr. of molasses) we found 3·8 to 4·5 after inversion.

Is the difference caused by the existence of crystallisable sugar still incompletely transformed? This is possible. With polariscopic analysis it is difficult to discover the presence of crystallisable sugar because the resulting deviations are so feeble and the liquors highly coloured, and the least error involves a great difference in the results.

To carry out the fermentation of cane molasses there is need in our opinion to determine the total amount of non-fermentable sugar both before and after inversion, and to note the difference between the two results.

Again, is it possible to obtain the complete fermentation of the reducing matter in cane molasses? Only experiment can prove this.

In the laboratory, fermentation experiments always indicate some unfermented sugar, but, on the other hand, certain yeasts appear more active than others.

What we have chiefly wished to demonstrate in this note is that cane molasses contain a certain amount of unfermentable sugar and that this explains why writers have not agreed as to the proportion of fermentable reducing agents, which have been fixed at from 80 to 94 per cent.

As the proportion of unfermentable sugar may be reduced by well conducted work with suitable yeast, we consider it advisable to determine the amount of reducing sugars in the lees before and after inversion.

In conclusion, we should state that the analysis of cane molasses presents many difficulties in obtaining an exact estimation of the crystallisable sugar and of the reducing agents, and that so far the method which appears to give the most accurate results is that adopted by one of us; this has been verified during the last few years by several of our specialist colleagues.

LEEWARD ISLANDS.

Experiments with Varieties of Sugar Cane during the Season 1902-3.

The annual report, issued by Mr. Francis Watts, Government Analytical and Agricultural Chemist at Antigua, is just published, and, as on former occasions, we reproduce below a summary of the chief points set forth. The experiments detailed therein have been conducted on the same lines as those previously reported on in past years, and it has been an essential feature that the canes should be cultivated in the same manner as the ordinary crop of the estate, so that close comparisons might be instituted. Antigua and St. Kitts have again been the scene of the operations.

Antigua.

In Antigua the rainfall for the season has been abnormal. April, May, and June, in many places, were unusually wet months. A dry period then followed; while in November an extremely heavy rain fell, followed again by a drought. In other places the rainfall proved beneficial, and large crops resulted. Thirty-five selected varities of plant cane were cultivated at one station, and twenty-three varieties on the remaining six stations. Pen manure was invariably used to the exclusion of artificial manures.

Table I. gives the means of results obtained with plant canes in Antigua. The returns per acre both of canes and sucrose are considerably smaller than last year, owing to the nature of the rainfall. The dry reaping season resulted in less juice being expressed per ton, but that was correspondingly richer in sucrose.

B. 208 again heads the list, thus confirming the opinion that it is worthy of careful attention on the part of planters. Not only does it produce a heavier tonnage of cane, but it is even more conspicuous for the quality and remarkable purity of the juice it yields. It likewise retains an excellent character when judged as a ratoon cane.

White Transparent occupies sixth place this year, as compared with twentieth last year; while the much vaunted B. 147 still occupies a relatively low place in these experiments. An interesting table appears

for the first time in these reports; it gives the relative positions (based on sucrose yield) occupied by the varieties of cane during the past four seasons, together with the mean for the four years. This table is worth studying, and is reproduced below (II). It must be pointed out, however, that several very promising canes,—*e.g.* B. 208—are not capable of inclusion in this comparison, owing to their being introduced at a later date than 1899-1900. It will be seen that B. 109 has improved considerably, and it seems to have outgrown the suspicions originally attached to it.

Ratoons.—The mean results are given in Table III. A comparison with last year's report shows that five out of the six which then appeared at the top again head the list. From the table it will be seen that nine varieties, in which some interest centres at Antigua, ratoon very well. Sealy Seedling heads the list, followed by B. 208, which latter yields a remarkable juice average of 2·36 lbs. sucrose per gallon. There is satisfactory reason for believing that those canes which commend themselves as plant canes have also the property of ratooning well.

TABLE I.

PLANT CANES.

MEANS DEDUCED FROM 14 PLOTS OF EACH VARIETY OF CANE.

No.	NAME OF CANE.	Cane.	Juice.		Sucrose.	
		Tons per acre.	Gallons per acre.	Gallons per ton.	Pounds per gallon of Juice.	Pounds per acre in Juice.
1	*B. 208	33·7	4,406	130·7	2·294	10,108
2	B. 109	33·2	4,467	134·6	2·060	9,204
3	*B. 156	35·5	4,612	129·9	1·990	9,177
4	D. 130	32·9	4,404	133·9	2·079	9,156
5	B. 306	29·9	4,104	137·3	2·214	9,088
6	White Transparent ..	28·8	3,816	132·5	2·169	8,278
7	D. 95	27·1	3,622	133·7	2·253	8,159
8	Burke	28·6	3,755	131·3	2·106	7,909
9	*Sealy Seedling	30·5	4,042	132·5	1·956	7,905
10	Mont Blanc	28·0	3,692	131·9	2·108	7,881
11	†D. 145..	28·1	3,938	140·1	1·964	7,736
12	Queensland Creole ..	27·7	3,634	131·2	2·096	7,617
13	Rappoe	27·1	3,543	138·0	2·103	7,451
14	*Red Ribbon	26·1	3,409	130·6	2·106	7,180
15	D. 102..	28·3	3,602	127·3	1·956	7,046
16	D. 74	26·3	3,476	132·2	1·991	6,921
17	Caledonian Queen ..	24·1	3,174	131·7	2·106	6,686
18	B. 147	23·3	3,144	134·9	2·038	6,409
19	D. 116..	24·5	3,237	132·1	1·975	6,393
20	Naga B...	22·4	2,991	133·5	2·124	6,354
21	*B. 176..	21·9	2,873	131·2	2·124	6,103
22	*D. 78	23·0	3,182	138·4	1·862	5,926
23	D. 115..	23·5	2,994	127·7	1·968	5,882

* Mean of 10 Plots only. † Mean of 11 Plots only.

Table II.

Order 1902-3.	Order 1901-2.	Order 1900-1.	Order 1899-1900.	Order from Mean of Four Years.
1. B. 109.	1. B. 109.	1. D. 95.	1. D. 95.	1. D. 95.
2. White Transparent.	2. D. 95.	2. Mont Blanc.	2. Mont Blanc.	2. B. 109.
3. D. 95.	3. D. 102.	3. Naga B.	3. Caledonian Queen.	3. Burke.
4. Burke.	4. Naga B.	4. Burke.	4. Naga B.	4. Mont Blanc.
5. Mont Blanc.	5. Burke.	5. D. 102.	5. D. 116.	5. Naga B.
6. Queensland Creole.	6. Caledonian Queen.	6. Red Ribbon.	6. B. 147.	6. D. 102.
7. Rappoe.	7. Mont Blanc.	7. White Transparent.	7. White Transparent.	7. White Transparent
8. Red Ribbon.	8. D. 115.	8. Queensland Creole.	8. D. 115.	8. Caledonian Queen.
9. D. 102.	9. Rappoe.	9. Caledonian Queen.	9. Burke.	9. Rappoe.
10. Caledonian Queen.	10. D. 116.	10. Rappoe.	10. Rappoe.	10. Queensland Creole.
11. B. 147.	11. Red Ribbon.	11. B. 109.	11. D. 102.	11. B. 147.
12. D. 116.	12. White Transparent.	12. B. 147.	12. Queensland Creole.	12. D. 116.
13. Naga B.	13. B. 147.	13. D. 116.	13. B. 109.	13. D. 115.
14. D. 115.	14. Queensland Creole.	14. D. 115.		

Note.—This list only includes the varieties under cultivation for four years. A number of other varieties have been under observation for shorter periods (see Table I.).

Table III.

ANTIGUA RATOON CANES.

Means deduced from 11 Plots of each Variety of Cane.

No.	Name of Cane.	Cane.	Juice.		Sucrose.		Position as Plant Cane.
		Tons per acre.	Gals. per acre.	Gals. per ton.	Pounds per gallon of Juice.	Pounds per acre in Juice.	
1	Sealy Seedling	24·9	3,101	124·5	2·007	6,225	9
2	B. 208	20·1	2,591	127·9	2·360	6,116	1
3	B. 109..	22·4	2,953	131·8	2·041	6,027	2
4	B. 306	20·0	2,754	137·7	2·171	5,979	5
5	D. 130..	21·8	2,820	129·8	1·973	5,583	4
6	D. 95	19·8	2,529	127·7	2·100	5,311	7
7	Rappoe	19·6	2,531	129·1	2·089	5,286	13
8	Burke	19·7	2,643	134·2	1·951	5,156	8
9	D. 102..	19·8	2,476	125·1	2·010	4,976	15
10	D. 74	19·1	2,487	130·0	1·943	4,833	16
11	White Transparent ..	17·1	2,230	130·4	2·151	4,798	6
12	Mont Blanc	18·7	2,352	125·8	2·037	4,792	10
13	Naga B.	17·2	2,243	130·4	2·135	4,788	20
14	Caledonian Queen ..	17·8	2,272	127·6	2·061	4,682	17
15	B. 156	17·8	2,278	128·0	2·045	4,659	3
16	D. 78	17·9	2,443	136·5	1·854	4,529	22
17	D. 116	17·3	2,314	133·8	1·947	4,505	19
18	B. 147..	15·9	2,131	134·2	2·092	4,457	18
19	*D. 145	17·2	2,194	127·6	1·998	4,381	11
20	D. 115..	17·4	2,170	124·7	2·012	4,365	23
21	Queensland Creole ..	15·3	1,942	126·9	2·111	4,100	12
22	†B. 176..	13·9	1,812	130·4	2·126	3,852	21
23	Red Ribbon	13·4	1,687	125·9	2·091	3,527	14

* Mean of 8 Plots only. † Mean of 10 Plots only.

St. Kitt's.

Plant Canes.—The mean results are given in Table IV. Caledonian Queen and B. 208 head the list. It will be noticed the former was only seventeenth in Antigua, while B. 208 tops the list in both places; but here the weight of cane is less in B. 208 than in Caledonian Queen, though in richness of juice B. 208 is the superior. As was expected D. 95 has not maintained its position, falling from third to fifteenth position. The light soils of St. Kitt's do not appear to suit it. B. 147 has not given very promising results in the experiments, though it is succeeding remarkably well on an extensive scale in some parts of St. Kitt's. In these experiments it gave a very large yield of cane sugar (11,838 lbs.) at West Farm, where it headed the list; at the other stations it was less successful. Apparently this cane is very sensitive to its surroundings, though doing well under favourable conditions.

Ratoon Canes.—These results appear in Table VI. Here there is a greater divergence than in Antigua between the order in which the canes range themselves as plant canes and ratoons respectively.

TABLE IV.

PLANTS.

MEANS DEDUCED FROM 8 PLOTS OF EACH VARIETY OF CANE IN ST. KITT'S.

No.	NAME OF CANE.	Cane. Tons per acre.	Juice. Gallons per acre.	Juice. Gallons per ton.	Sucrose. Pounds per gallon of Juice.	Sucrose. Pounds per acre in Juice.
1	†Caledonian Queen ..	41·3	5,410	131·0	1·763	9,537
2	*B. 208	35·3	4,601	130·3	2·066	9,504
3	Rappoe	39·3	5,140	130·8	1·762	9,057
4	Queensland Creole ..	39·9	5,228	131·0	1·722	9,000
5	B. 306	32·8	4,553	138·8	1·932	8,795
6	D. 115	36·8	4,976	135·2	1·731	8,612
7	Mont Blanc	35·2	4,682	133·0	1·828	8,556
8	B. 376	36·4	4,910	134·9	1·722	8,457
9	Jamaica	34·5	4,583	132·8	1·843	8,447
10	Naga B...	33·6	4,518	134·5	1·782	8,049
11	D. 116	33·4	4,460	133·5	1·791	7,989
12	D. 74	31·0	4,062	131·0	1·909	7,756
13	B. 109	34·8	4,570	131·3	1·671	7,637
14	*Striped Singapore ..	34·5	4,579	132·7	1·667	7,631
15	D. 95	26·3	3,472	132·0	2·068	7,178
16	White Transparent ..	30·9	4,113	133·1	1·658	6,821
17	B. 393	27·1	3,681	135·8	1·852	6,819
18	*B. 147	29·5	3,915	132·7	1·739	6,807
19	B. 254	27·4	3,615	131·9	1·781	6,438
20	D. 145	29·2	4,088	140·0	1·551	6,339
21	Rock Hall	28·5	3,852	135·2	1·492	5,748

† Mean of 6 Plots only. * Mean of 7 Plots only.

Another interesting table is one giving a description of the canes. From it we select a few of the best varieties.

In conclusion, we would congratulate Mr. F. Watts on the extremely lucid and practical manner in which he draws up his annual reports. While necessarily voluminous, they are so arranged that one can easily obtain the main features, and the conclusions to be drawn therefrom, without the labour of wading through wearisome columns of tables. The summarising tables are particularly helpful, and the notes and comments do not err on the side of verbosity. We think the compilers of Trinidad and Barbados reports might very well take a leaf out of his notebook.

TABLE V.

DESCRIPTION OF CANES.

Cane.	Colour.	Habit.	Foliage.	Arrows.	General Remarks.
White Transparent Naga B. Caledonian Queen Rappoe Mont Blanc	Grey or pink tinged	Inclined to trail	Broad dark-green leaves	Freely	Easily grown and withstands drought fairly well.
D. 95	Dark purple	Very erect	Light-green, narrow erect leaves	Profusely	Eyes prominent, tending to sprout, plants easily grown.
B. 147	Yellow	Inclined to trail	Broad dark-green leaves	Very sparsely.	Trash clings to cane until ripe, joints long and medium size. Somewhat difficult to establish. Cane soft with hard rind.
B. 109	Green to yellow	Erect	Leaves dark-green	Sparsely	Joints stout and of good length; trash leaves cane easily.
Queensland Creole or Purple Transparent	Purple-red	Erect	Narrow dark-green leaves	Freely	Joints rather slender, hardy cane, easily grown.
Burke	When ripe, very like White Transparent, with greater tendency to trail.				
Sealy Seeding	Green	Erect	Narrow erect leaves.	Profusely	Large number of canes to stool, great tendency for eyes to develop into shoots.
B. 208	Green	Erect	Leaves growing vertically	Sparsely	Cane stout with very prominent eyes, tending to sprout.

Table VI.

ST. KITT'S RATOONS.

Means deduced from 6 Plots of each Variety of Cane.

No.	Name of Cane.	Cane.	Juice.		Sucrose.	
		Tons per acre.	Gallons per acre.	Gallons per ton.	Pounds per gallon of Juice.	Pounds per acre in Juice.
1	*B. 306	22·5	3,004	133·5	2·003	6,619
2	D. 115	24·9	3,181	129·4	1·902	6,051
3	B. 147	25·4	3,200	126·0	1·879	6,013
4	Jamaica	21·4	2,735	127·8	2·000	5,470
5	White Transparent ..	21·2	2,606	122·9	1·961	5,111
6	B. 376	20·5	2,557	124·7	1·934	4,945
7	D. 74	20·0	2,451	122·6	2·001	4,904
8	B. 393	19·8	2,515	127·0	1·940	4,878
9	D. 95	19·7	2,373	120·5	2·048	4,861
10	†B. 254	21·4	2,568	120·0	1·877	4,820
11	Burke..	17·6	2,556	145·2	1·860	4,754
12	Queensland Creole ..	21·6	2,468	114·3	1·915	4,727
13	D. 116	21·3	2,572	120·8	1·801	4,633
14	*B. 109	18·8	2,347	124·8	1·955	4,590
15	*B. 208	17·3	2,124	122·8	2·141	4,547
16	Naga B...	17·9	2,239	125·1	2·009	4,498
17	Mont Blanc	19·0	2,268	119·4	1·963	4,452
18	Rappoe	19·5	2,310	118·5	1·865	4,307
19	*B. 176	11·2	1,395	124·6	1·866	2,603

* Mean of 5 Plots only. † Mean of 4 Plots only.

The first sugar experiment station to be started in Mexico is being erected on the Isthmus of Tehuantepec. It will be aided by Government support.

Attempts to start sugar manufactories in Burma have hitherto met with failure, owing to the difficulty of getting sufficient cane. Practically all the Burmese sugar cane is utilized for making jaggery, and all refined sugar used in the country has to be imported. Nevertheless the sugar cane might be profitably grown in many more places than it is at present.

RAW BEETROOT SUGAR.

The Cost of Production in Germany.

In a paper read before the Royal Statistical Society in April, 1899 (*Journal*, June, 1899, page 321), I gave some estimates on this point. Five years have elapsed since then, and it may be well to revise the figures. The results of the German factories are published in some detail, but unfortunately not according to a uniform system. The cost of manufacture, for instance, is in most cases given without including the charge for deterioration in the value of plant. There is also no charge made for interest on capital. The following figures give, therefore, somewhat too low an estimate of the cost of production. But the great change during the last five years has been the remarkable increase in the yield of sugar from the roots. This is no doubt owing in part to the weather, and in part to greater skill in manufacture, or to improvements in the quality of the seed.

M. F. Sachs gives an interesting *résumé* in the *Sucrérie Belge* of the 15th March, of the factory returns; but, the figures of the average yield are quoted from M. Glanz, as published in the *Zeitschrift*, of Berlin. They are as follows:—

	Per cent. of Raw Sugar.		Per cent. of Raw Sugar.
1897-8	12·79	1900-1	14·14
1898-9	13·37	1901-2	13·63
1899-90	13·58	1902-3	14·60

The question naturally arises, are these higher figures likely to be permanent? If they are it is very necessary to make a new estimate of the cost of production of beetroot sugar under the specially favourable conditions prevailing in Germany. The German cost will in all cases indicate the minimum, and will be considerably below the average cost for the whole of the European beetroot districts.

There was no great change in 1902-3 in the price of roots or in the cost of manufacture, as compared with the figures given by me in 1899. The averages arrived at by M. Sachs are the result of the examination of 56 factory returns. Thirty of these are from factories working from 30,000 to 155,000 tons of roots. These large factories show an average of 9·04 francs per ton of roots, as cost of manufacture without including charges for interest or depreciation. But even some of these large factories went up to 10, 11, and 12 francs in their working expenses. Others were as low as 7 francs. The remaining 26 factories worked from 11,000 to 27,000 tons of roots, and their working expenses came out on the average 11·54 francs per ton of roots. But though these were the smaller factories some of them managed to work at a cost of only 10, 9, or 8 francs. The average

price of the roots in the large factories was 23·52 francs per ton, and in the smaller ones 21·69 francs. The variations are considerable, the prices ranging from 27 francs to 18 francs.

The average price of the roots for the whole of the 56 factories may be taken at 22 francs, and the working expenses at 10·21 francs. These figures, reduced to pence per cwt., come out:—

	Pence per cwt.
Price of roots	10·56
Working expenses	4·9

as compared with $10\frac{1}{2}$d. and $4\frac{1}{4}$d. given by me in 1899.

The yield of sugar is of course the most important element in the calculation. My calculations were based on 8 cwts. of roots to 1 cwt. of sugar; but I pointed out that a hundredweight of sugar is often produced from less than eight hundredweights of roots. The round numbers which serve as a guide are as follows:—

				Roots.		Sugar.
A yield of	12·3	per cent.	is equivalent to	8 cwts.	to	1
,,	13·3	,,	,,	$7\frac{1}{2}$	,,	1
,,	14·3	,,	,,	7	,,	1

The great increase in the yield since 1899 shows that we must now take 7 to $7\frac{1}{2}$ cwts. of roots as our new coefficient. It will be interesting to see, as time goes on, whether this coefficient has to be raised again or further diminished. In 1899 the figures were as follows:—

	s.	d.
$8 \times 10\frac{1}{2}$d. =	7	0
$8 \times 4\frac{1}{4}$d. =	2	10
Cost of sugar, per cwt. ..	9	10

According to the latest figures, $4\frac{1}{4}$d. is too low, and has to be raised again to nearly 5d.; $10\frac{1}{2}$d. as the cost of roots remains as before, and the coefficient, according to the season, must be reduced to $7\frac{1}{2}$ or 7 At a yield of 13·3 per cent. the coefficient is $7\frac{1}{2}$; at a yield of 14·3 per cent. it is 7.

I. Cost of production at a yield of 13·3 per cent.:

	s.	d.
$7\frac{1}{2} \times 10\frac{1}{2}$d. =	6	$6\frac{3}{4}$
$7\frac{1}{2} \times 4{\cdot}9$d. =	3	$0\frac{3}{4}$
Cost of production, per cwt. ..	9	$7\frac{1}{2}$

not including interest on capital or depreciation.

II. Cost of production at a yield of 14·3 per cent.:

	s.	d.
$7 \times 10\frac{1}{2}$d. =	6	$1\frac{1}{2}$
$7 \times 4{\cdot}9$d. =	2	$10\frac{1}{4}$
Cost of production per cwt. ..	8	$11\frac{3}{4}$

not including interest on capital or depreciation.

It may, therefore, now be asserted that, for the whole of Europe, the cost of production of raw beetroot sugar is considerably more than 9s. per cwt.; because it is universally admitted that the cost in Germany is lower than in all other European countries, especially France and Russia.

GEORGE MARTINEAU.

SEEDLING CANE CULTIVATION.

Marked and gratifying progress has been made with seedling cane cultivation since that day many years ago when Professor Harrison and Mr. Bovell in Barbados, in order to determine the fertility of the seed produced by the sugar cane in tasseling, carefully cleaned, as Dr. Blouin, of Louisiana, reminds us, the ground on the leeward side of a field of cane about to tassel and prepared it to receive such seed as might be blown over by the winds and find a suitable soil to lodge in. The outcome of the enterprise thus unostentatiously begun, is the present extensive seedling cane experiments and cultivation carried on wherever sugar cane is grown. In this colony since the Professor's advent the planters have loyally supported him in his labours, and although recently there has been some difference of opinion between him, or the Board of which he is Deputy Chairman, and a leading planter as to returns that should be made for the preparation of official reports, there has always been the most generous recognition of the immense value of his investigations in connection with the sugar industry. Professor Harrison does not proclaim his doings from the housetops, but quietly pursues his labours, letting the results speak for themselves. We do not believe there is another worker in the domain of his particular science whose name is so universally known, not even excepting Dr. Kobus, of Java, whose experiments have been carried on currently with those of the Professor, and whose writings are familiar to all readers of sugar journals. Professor Harrison seldom writes to periodicals, and rarely prepares reports other than those necessary for the furtherance of his departmental work; nevertheless in India, Egypt, Australia, East Indies, West Indies, the United States, South America, wherever sugar cane is grown, and even on the Continent and in sugar circles at home, his name is a household word, and his conclusions accepted without question. It must be a matter of considerable satisfaction to him to know that he is the proverbial exception to the prophets, and that in the West Indies and in this colony his efforts are even more highly and justly appreciated than they are abroad. The report submitted to the Board of Agriculture on Friday shows the extent to which seedlings are being cultivated here. The returns show that 12,860 acres are occupied with large scale experiments in varieties of

sugar cane other than Bourbon—and mostly seedlings—9,150 acres being in Demerara, 2,791 in Berbice, and 929 in Essequebo. The total area when compared with 9,518 acres in 1902-1903 and with 6,282 acres in 1901-1902 shows an increase upon them at the rates of 31·5 and 104·7 per cent. respectively. Of the varieties other than Bourbon in cultivation D. 109 heads the list as occupying the most extensive acreage. Thirty-one estates devote an aggregate of 3,338 acres to it, as against ten estates with an acreage of 341 in D. 95 and 11 estates with 223 acres in D. 74. It is interesting to note that of all the seedlings tried in Louisiana, D. 74 and D. 95 have been the most successful. In a paper on the subject which he read recently before the Louisiana Planters' Association, Dr. Blouin, Assistant Director of the Sugar Experiment Station there, stated that seedlings had been received from every available sugar producing portion of the globe, and they had not until the introduction of D. 74 and D. 95 forwarded by Professor Harrison, discovered any cane superior to the Louisiana Purple and the Louisiana Striped. Other seedlings are still under experiment, but it has been proved conclusively that D. 74 and D. 95 are of a superior merit to the Louisiana stock. Dr. Blouin describes them as follows: "D. 74 is a tall, erect green cane, with long joints, a deep green foliage, long and deep roots, suckers or rattoons abundantly, has a large sugar content; the individual stalks are large and heavy, and it has uniformly given a large tonnage during the ten years which it has been on trial at the Louisiana Sugar Experiment Station. The leaves are upright in growth and adhere closely to the stalk, a condition which should be noted in harvesting, owing to the tendency to top the cane too low. It is a soft cane yielding a very good extraction. D. 95 is a large, erect purple cane, lighter in colour than our home cane, long joints, a pale green foliage, long and deep roots, suckers or rattoons well, has a large sugar content, and large individual stalks, though not as large as D. 74. Its leaves are upright in growth, though not as pronounced as D. 74. In harvesting the same precautions should be observed as in D. 74. A special study of these canes covering the roots, stalks and tops developed the fact that the centre of gravity was near the ground, and such is the reason for the erect growth of these canes. In tropical countries, both of these canes have been noted for their early maturity, a condition unfavourable with them, but of great advantage to us in Louisiana. Both of these canes are very hardy, having passed through the winters of 1895 and 1899 equally as well, if not better than our home canes, as our records prove." The discussion which followed the reading of Dr. Blouin's paper disclosed that in the experience of Louisiana planters, D. 74 was superior to D. 95, and D. 95 superior to the popular Louisiana varieties.—(*Demerara Argosy.*)

THE NECESSITY OF CHEMICAL CONTROL IN THE DISTILLERY.

BY M. F. VERBIÈSE.

(Continued from page 194.)

II.—INVISIBLE LOSSES.

These are perhaps more serious than the preceding for they may exist unsuspected during an entire campaign, and even during several campaigns. They mainly include :—

1. Loss of sugar in the pulps.
2. Loss of alcohol in the spent-wort.

Let us first consider the pulps by citing a typical example. In a distillery, to which we were called to correct a faulty fermentation last campaign, we took some samples of the pulps and spent-wort in order to judge of the general efficiency of the work.

To our great surprise, the first analysis of the pulps revealed an actual sugar-content of 3·93 %. Other samples taken later showed 3·68, 3·88, &c.; the amount varying between 3·5 and 4·0 %.

With good work the pulps should have an average sugar-content of 1·5 %, whence it follows that these pulps contained an excess of 2 % or more of sugar from the commencement of the campaign, and probably this was the case during previous campaigns.

It is a simple matter to determine the cost which such a loss would represent for a normal campaign.

100 kilos of pulp contain in excess 2 kilos of sugar.
1,000 ,, ,, ,, 20 ,,

For 1,000 kilos of roots worked there are lost $\frac{20 \times 25}{100} = 5$ kilos sugar, and for a daily capacity of 130 tons, $5 \times 130 = 650$ kilos.

These 650 kilos of sugar lost would have yielded 58 litres of alcohol per 100 kilos of sugar, or $\frac{650 \times 58}{100} = 377$ litres of alcohol at 100°, or 419 litres at 90°. Valued at 35 fr. per hectolitre, $4{\cdot}19 \times 35 = 146$ fr. 65. This undeniable loss per day continuing for one campaign will therefore about to 14,665 fr.

We have found equally high losses in two different usines during the course of last campaign. "Had I known this when I commenced six years ago, I would have saved 50,000 fr.," said one of the two distillers despondently. All that was necessary was to have analysed his pulps, a practice which had never appeared to him as of any use, although his pulps on merely tasting must have appeared very rich in sugar.

To return to the case cited above, we may state that by a single alteration of a badly installed macerator, and attention to the conditions of

temperature essential for a good extraction, the losses in the pulps were reduced to 1·93, 1·87, 1·66% and lower.

An example such as the preceding is rarely met with, but, as a general rule, the content of sugar in the pulps is too high, and is almost always reduced by a little more care; by more frequent inspection of the knives if the cossettes are at fault; by attention to the macerators and the presses.

But how remedy a fault which is not known? This can only be done by a regular control of the pulps, and when this is adopted a greatly reduced sugar-content in the pulps will almost invariably result.

It is a simple matter to arrive at the cost corresponding to a reduction of only 0·5%, that is to say, the difference between fair average work leaving 2% sugar in the pulps, and good work leaving 1·5% sugar; 0·5% of sugar represents 5 kilos to the ton of pulp, or $\frac{5 \times 25}{100} = 1{\cdot}25$ kilos per ton of roots. For a day's work of 130 tons of roots there are lost 162·5 kilos of sugar, which would have yielded, at a return of 58%, 94·25 litres of alcohol at 100°, or 105 litres at 90°.

There is, therefore, a loss of $\frac{105 \times 35}{100} = 36$ fr. 75 per day, or 3,675 fr. for a campaign of 100 days.

As regards the maceration, we have met with sugar-contents of 0·70, 0·85, and even 1·0 %, when these might easily have been maintained at 0·50 and even 0·40 %.

Assuming a reduction of only 0·2 % let us see what this apparently insignificant improvement amounts to.

A loss of 0·2 kilos per 100 kilos pulp is equal to 2 kilos per ton of pulp. On a ton of roots the loss is $\frac{2 \times 65}{100} = 1{\cdot}30$ kilos, and for a day's work of 130 tons, $1{\cdot}3 \times 130 = 169$ kilos of sugar, representing $\frac{169 \times 58}{100} = 98{\cdot}02$ litres of alcohol at 100°, or 109 litres at 90°, which makes a loss of $\frac{109 \times 35}{100} = 38$ fr. 15 per day, or 3,815 fr. per campaign of 100 days. This loss appears to us to be worth attention.

The other source of loss referred to above is the loss of alcohol in the spent-wort. Last year we analysed worts containing as much as 0·50 % and even 0·73 % of alcohol. We think that these cases must have been accidental, for the loss from this cause must have been too serious to have existed for any length of time unperceived, since the original wort rarely contains more than from 2·5 to 3·5 % of alcohol.

But, generally speaking, the distillation is a point to which too little attention is paid. In certain usines it may even happen that from 0·10 to 0·15 % is considered as a normal and even negligible quantity of alcohol in the residual wort.

Now, what does this loss of 0·10 % amount to? To 1 c.c. per litre, to 100 c.c. per hectolitre, to 1 hectolitre of alcohol at 100° per 1,000 hectolitres of wort. If a record were kept of the thousands of hectolitres of spent-wort discharged during a campaign, one might say that that number also represents the hectolitres of alcohol lost, and then judge whether the quantity is really negligible!

The spent-wort can and must be entirely deprived of alcohol. Amongst all the distillers, whose work we have followed during the last campaign, their spent-worts incidated exactly zero on the alcohometer, and we conclude that in nine cases out of ten, if the degree of exhaustion is indifferent, the cause is solely due to the method of operating the column; the cases are very rare when this lost really results from the wear of the trays or from defective construction.

III. Some Proposed Improvements.

Let ns next consider the work of a distillery when the acidity is regularly tested and the pulp and spent-wort carefully analysed, in a word, where chemical control is suitably adopted. Is there no other improvement in the technique of the work which might be suggested? To reply in the negative would be to claim that one has arrived at the "maximum yield with the minimum cost." Now we think that this ideal is very rarely realised, and that, even in the case of those distillers whose work is very efficient, and for whom this last section of our paper is more especially intended, certain points may still be susceptible of improvement. Their anxiety to do better may, in our opinion, bear fruit in the following points:—

1. The raw material.
2. The method of extraction.
3. The fuel.
4. The working plant.
5. The fermentation.

1. The Raw Material,

It is a fact that the most conservative of distillers begin to realize that nothing is more delusive than the use of the hydrometer for determining the true value of a beetroot, and that the poorer the root is the greater the errors to which the exclusive use of the hydrometer leads.

With the distiller, as with the sugar manufacturer, it is only the saccharine richness which should be the basis of the price of purchase. The alcohol is formed only from the sugar, whereas the salts, which more or less influence the density, are rejected with the spent wort.

Now, whereas in the sugar factory, each lot of roots is examined with the polariscope, there are very few agricultural distilleries where it is in constant use.

But this instrument, although frequently met with wherever the methods of working are not primitive or completely out of date, is

yet generally regarded as an object of curiosity, or a luxury. It is sometimes used during the course of a campaign, for example, when the roots show a very high or a very low density "to see how much they contain," but it is never in the place of honour, on the working bench by the side of the microscope and the acidimeter.

That the roots continue to be purchased by the density, or even by contract, matters little; what we wish to establish is that the distiller has a direct interest in knowing exactly the sugar-content of his roots, so that he may ascertain whether he recovers a corresponding yield of alcohol. Besides, by an intelligent use of this instrument he will discover that the roots from this field, that farmer, or such-and-such lands are sweeter, or are more saline than others of equal densities; that certain lands, heavily manured, produce beautiful roots of sufficient density, but poor in sugar, and, consequently, of inferior value; that, on the contrary, in a given village or district, according to the composition of the soil or the nature of the manures employed, the roots are very pure; that their density is not deceptive, but that they are very productive of alcohol; he will observe amongst his own farmers, those who sell him the most sugar for an equal weight of roots, and, aided by all these observations, he will arrange his purchases in such a manner that, for equal disbursements, he will obtain a greater quantity of alcohol than his neighbour, who allows himself to be guided by the deceptive indications of the hydrometer.

Do not let us lose sight of the supposed fact that the percentage of sugar is equal to double the density, for, though this may be true of densities bordering on 7°, this coefficient decreases with the density so that a root showing 4° density, for example, rarely contains more than 6·5% of sugar; we have found densities of 4·2° with percentage of sugar of only 6·0. On this subject we will quote another example. During last campaign a distiller gave us the following problem which had perplexed him for 15 days:—

"How is it possible that the Excise find that, this year, I take 150 kilos. more roots to produce 1 hectolitre of alcohol than I did last year, although the mean density of my roots is at least as high as in former years, and my work has progressed favourably?"

We, first of all, decided to verify the efficiency of the work: we examined his fermentations: good; his pulps, spent wort, attenuations: all were normal. There was no excessive loss in his extractions. We thought for a moment of loss by leakage, but on examining his condenser and other apparatus we found all in good order.

We arrived at the conclusion that, since nothing was lost, we ought to find alcohol equivalent to the sugar introduced and that, conversely, if the alcohol is deficient, it is because the sugar itself is present in small quantity.

Questioned on this point the distiller declared that the last year he and his neighbours, lacking raw material, had bought nearly all that

had been brought them, and that many roots which, in ordinary times, would have been used as fodder, had been mixed with his usual supply of roots. The cause of the deficiency was then discovered.

The previous year the density of the roots was much below the verage, the mean density of his present receipts, notwithstanding the admixture of forage roots, very nearly reached that of former years, but the salts introduced by these roots, the purity of which was very inferior, could not play the rôle of sugar in the fermentation; hence the deficit in the yield of alcohol. The fault was proved by analysis, for some of the roots did not contain even 6% of sugar.

Had the distiller made certain saccharimetric tests from time to time in order to determine the true value of separate lots of roots, he would have avoided working at a loss and spared himself several weeks of investigation and anxiety.

2. The Method of Extraction.

We shall not here consider which is the most rational method of extraction; but content ourselves with pointing out a defect frequently met with in the distillery, and which consists in drawing an excessive proportion of juice from the macerators per 100 kilos of roots. This arises from the very legitimate fear of not sufficiently exhausting the pulps, but, on studying this question more closely, it is very often found possible to very materially reduce the volume of juice drawn without increasing the quantity of sugar left in the pulp; it suffices to closely watch these factors which determine the extraction, the state of division of the pulps or cossettes, the temperature of the diffusers, and the duration of contact.

Very often one corrects a fault in one of these three factors by increasing the proportion of juice drawn; it will, however, be more rational to maintain that these three points should be in perfect harmony; the proportion of juice drawn could then be reduced to a minimum which it would be imprudent to exceed, exactly as in the sugar factory. The advantages gained by this reduction in volume of juice drawn are moreover the same in the one case as in the other—the increase in the work and reduction of general expenses; the subsequent treatment of the juice, whether by distillation or evaporation, is applied to a smaller volume with a considerable economy in fuel.

The distiller should not fear that in reducing the volume of juice drawn it will be too concentrated; juices at from 3·5° to 4° density ferment quite as well as juice of 2·5°, moreover the cost of acid is lowered; the only thing to watch is the degree of exhaustion of the pulps. To repeat, an excessive draw of juice is perfectly useless if the extraction is properly conducted, or is at best only a costly remedy for a defective extraction

(To be continued.)

PROCESS FOR OBTAINING PRODUCTS FROM BEET SUGAR SIMILAR TO COLONIAL SUGAR.*

BY DR. H. WINTER.

For a long time it has been known that raw sugar obtained from the working up of beets has a disagreeable taste, such as to prevent its direct consumption, whereas the final product in the working up of the sugar cane, in the unrefined state, possesses a palatable taste, which even excels that of the refined article, and this entirely on grounds that have nothing to do with taste or the act of refining. It is generally said that cane sugar is sweeter than beet sugar; it would be more correct to say that chemically pure sugar has the same taste whether obtained from cane or beets. The ingredients, however, are nauseous in the case of beets, and palatable in the case of cane sugar: therein lies the difference in the raw products and the explanation of the higher market price of colonial sugars.

The present invention takes into consideration the fact that it is of considerable importance for consumption as well as for many industries, notably marmalade and fruit preserving, chocolate and sparkling wine manufacture, also for exporting purposes, to place on the market a product as nearly similar as possible to cane sugar, and one having the same taste and similar properties. Such a product can now be obtained by the method herein submitted. The endeavours hitherto made in this direction did not result in a practicable solution of the problem; they are briefly indicated at the close of this article. The present process is the first one to attain the desired purpose by simple and cheap means, and is based on an accurate knowledge of the factors involved. It is applicable to all kinds of beet sugar (raw molasses and refined), and should yield both consumption sugar and raw sugar.

From numerous experiments carried out in Java it has been shown that the palatable taste possessed by cane sugars depends in the first instance on the reducing sugar (mainly dextrose and invert sugar) contained in the syrup adhering to the crystals. Further a *rôle* is played by the conversion products (Umsetzungsproducte) of these reducing sugars, which arise during manufacture through the influence of the lime and alkalies under heat, and furthermore remain adhering with the mother lye to the crystals.

All traceable existing aromatic ingredients of cane juice, to which a certain importance has so far been ascribed, are for the most part either destroyed or else volatilized through contact with the lime and alkali in the subsequent heating of the juice of several hours' duration, and do not exist in appreciable amounts in the final product.

One can therefore impart the essential characteristics of colonial sugar to beet sugar, inasmuch as one can replace the original mother

* For specification see this month's Patents.

lye adhering to the crystals wholly or partially by a syrup which contains either invert sugar, dextrose, levulose, or mannose, or a mixture of such sugars, and thus increase the action, by mixing the covering syrup with the reducing syrup destroyed through the action of lime or weak alkali under the heat.

The idea of casing sucrose crystals with a layer which contains reducing sugar, in order to give to the beet sugar the characteristics of cane sugar is entirely new. It is true the American patents 145460, 264035, 153626, and 457439 described processes in which the mixing of saccharose with dextrose was established; invert sugar and other hexoses were not however employed as dextrose, and were moreover not able to take the place of grape sugar as is the case with the present process. Furthermore the cited processes used other means than the present one, and yielded products which could not be placed on the market as artificial colonial sugar. The first concerned pure refined, the second saccharose-containing grape sugar, the third solid loaf sugar, and the fourth candy.

Mixing of saccharose with invert sugar has all along been known in the artificial honey industry. There, however, it is a question of thick fluidity or pappy mass. To the establishment of this and the above-mentioned products the present process lays no claim. It primarily strengthens the similarity between beetroot sugar and cane sugar where the addition of reducing sugar, in the form of a thin layer, is made to the former, and in some instances through the addition of decomposed reducing sugar.

The changes which invert sugar and other hexoses suffer through the influence of lime or weak alkalies are as yet little known. Existing literature, much of it very old, gives contradictory conclusions of little value. More light is thrown on the subject by the later conclusions of Prinsen Geerligs concerning glucinic acid, which plays an important rôle in cane sugar manufacture. Under certain conditions it, as well as its salts, yields stronger inverted acids with the loss of carbonic acid, and thereby gives occasion for the so-called frothing of the runnings, and to loss of sugar through inversion of the saccharose. With the customary working methods in earlier decades, rich amounts of such unstable bodies occurred in the molasses, and gave them to a liberal extent the so-called cane sugar aroma; but under modern methods, which reduce the formation of these bodies to the smallest compass and in obtaining as much after-products as possible lead to widespread decomposition, it is a regular thing for nauseous and evil smelling substances to arise out of the reducing sugar.

In order to imitate the characteristics of the colonial sugar this invention can be used; the process should be carried out as follows:—

Beet sugar is freed to the greater extent of the adhering motherlye by casing with steam or a little water, and then in the centrifugal or

other receptacle is cased with the syrup which contains the reducing sugar in such a manner that the finished product contains the desired proportion in reducing sugar, after which it is treated in the customary manner. Naturally, one can introduce more or less reducing sugar into the product, according to the grade of taste and character that one desires to impart. Likewise the object for which the sugar is destined plays a part here. One can equally make the addition of the conversion products of the hexoses correspond with the alkali according to the purpose for which the finished product will serve.

As a guide to the production of a syrup for covering the sugars, the following example will serve:—

(*a*) Pure beet sugar is dissolved in boiling water, so that the solution on cooling shows about 65° to 68° Brix.

(*b*) Invert sugar is prepared after Herzfeld's formula, in which 500 gr. of tartaric acid are dissolved in 100 litres of water, and after heating to boiling point, 400 kg. of pure sugar are introduced, when the whole is further warmed till levo-rotation in the polariscope no longer increases.

A mixture of *a* and *b* in the proportion of 1:1 to 3:1 yields a covering syrup for the case where it is only desired to approximate the characteristics of the colonial sugar or to turn out faintly coloured consumption sugar. Naturally, any known method can also be adopted for producing the inversion.

For the case where products similar to the golden yellow cane sugar of strong aroma are desired, the solution is made as follows:—

(*c*) 1000 kg. of the invert sugar solution *b* are thoroughly mixed with three litres of soda lye of 50 % $NaOH$ (sp. gr. 1·53), heated to boiling point and kept there for three minutes. Thereupon a fresh supply of three litres of soda lye is introduced by permixtion and heated from three to six minutes. Within this time a weakly acid reaction reveals itself in the darkly coloured fluid by the frothing up and lighter colouring of the syrup. One can naturally also employ a weakly alkaline re-action. This disappears on drying and spreading of the sugar.

The solution *c* (1000 kg.) with the partially decomposed invert sugar is mixed after cooling with say 300 kg. of the solution *a*, and then employed for soaking 1500 kg. of sugar. The centrifugalled syrup can naturally be employed once more for soaking further quantities of sugar, or can be realised as "colonial syrup."

For the production of syrup *c*, potash lye or caustic lime can be used in the place of soda lye. The separation of the original salts is not necessary, since in the final product only a few tenths per cent. are present. If a darker colouring is desired the existing weakly acid reaction is raised by the addition of alkali till it is changed into a weakly alkaline reaction. Instead of invert sugar one can use other

hexoses in the specified manner, so as to obtain decomposing products with a similar action.

Certain circumstances may also lead to a form of practice such that one brings to the boil a solution which contains hexoses or this and the above-mentioned conversion products (glucose acid for instance), before drawing off the finished product. Finally one can also obtain a final product through partial inversion in a pure sugar solution and through partial breaking up of the invert sugar with alkali in the same manner as is customary in the cane sugar industry by further boiling to grain and centrifugalling, which final product contains hexoses and the above-mentioned conversion products. In this case not only does the mother lye adhering to the crystals contain substances which yield a taste and character similar to cane sugar, but also the traces of mother lye which are frequently found in the crystals.

As far as concerns the attempt to obtain from beet sugar a product similar to cane sugar, there are the Patents 36842 and 13687 to be mentioned. They differ, however, very essentially from the present process. In the case of the first one, the beet sugar is not treated with a casing of reducing sugar the conversion products of which are alkalied, but mixed with sulphuric acid under avoidance of inversion and then centrifugalled. The acid is to take away the bad smell and taste. Its feasibility is open to question in a factory with iron centrifugals; the working is doubtful to say the least, and the means by which the end is attained differ entirely from those of the present process.

In Patent 13687 natural cane sugar molasses or concentrated cane sugar solutions are employed for casing the sugar crystals; this involves no imitation, but only a simple mixing of two existing substances whilst the knowledge as to whence the palatable taste of the colonial sugars in opposition to beet sugar is derived, and the inventive idea how it is to be artificially produced, is not touched upon at all. The employment of concentrated cane sugar solutions can besides only lead to the washing away of crystals; what remains upon these can yield no possible influence on the taste and character, as the following consideration will show.

Cane sugar consists of about 95 per cent. pure sucrose, about $1\frac{1}{2}$ per cent. water and $\frac{1}{2}$ per cent. mineral matter. If we assume that the half of the remaining 3 per cent. consists of such organic substances as have the desired effect, and that it were possible to incorporate 5 per cent. of colonial sugar with the best beet sugar by casing, then there would be at the most 0·075 per cent. of such organic matter present, whereas the genuine colonial sugar as well as the sugar treated by the present process contains, or can contain, in the mean from $1\frac{1}{2}$ to 2 per cent. of such matter. There is as little to recommend in the employment of cane molasses as in the two other forms of procedure and it offers considerable difficulty in practice. It must be seen that the

transport of a liquid substance in casks or the like will entail great cost for packing and freight, apart from the fact that the sending is rendered almost unfeasible owing to the so-called froth fermentation. The cane molasses contains as above mentioned that easily decomposed substance (glucinic acid and products of decomposition) which break up with the loss of carbonic acid, and since the higher temperature which exists in the hold of the ships coming from the tropics favours the formation of froth fermentation, the bursting of the casks and considerable loss of substance is to be feared. Furthermore the importation of colonial sugar products is handicapped by a duty, which would render its profitable employment out of the question. Again it must be borne in mind that the cane molasses of the colonies is now already through repeated long boiling up to obtain after-products very strongly decomposed and contains, besides the glucinic acid, several bitter brown products having a disagreeably carameline smell and possesses no longer the aroma peculiar to the first products of the cane sugar industry.

These difficulties and considerations are surmounted by the present process. It requires no ingredient from distant climes, and moreover solves the problem of obtaining a final product from the output and expedients of the beet sugar industry which shall imitate the chemical characteristics of cane sugar in a simple manner. Transport costs, packing, and taxes do not arise, and one has it in one's power to undertake the decomposition of the freshly prepared reducing sugars just so far as is needed for the desired action, and yet not far enough to approach the alleged disagreeable smell of the cane molasses. Finally, full cleanliness in carrying out the process is guaranteed. All these commercial advantages give a superiority to the present process over its predecessors.

Again, as compared with the genuine cane sugar, the artificial imitation has a great advantage. The habit of placing unrefined cane sugar in the market is open to grave question, even in those lands where the conditions of duty allow this transport, when it is remembered that such colonial sugar is infested by a number of insects and other animalculæ. The artificial colonial sugar from this process is not really raw product, but a product of refining, and in virtue of the method of its production fully sterile; therefore the fear that it harbours microscopical tropical organisms is groundless, in spite of its rivalling the tropical sugar in taste and other characteristics.

As an aid to the competition of the beet sugar in the world's market, we have here under consideration the fact that with this new process we can produce sugar which is fully equal in analysis and characteristics to cane sugar, and can lay claim to the higher price which the latter at present enjoys.—*(Oesterreichisch-Ungarische Zeitschrift.)*

Correspondence.

THE INTERPRETATION OF THE "SURTAX."

To the Editor of "The International Sugar Journal."

Sir,—In the article on "The Progress of Experimental Sugar Beet Culture in the United Kingdom," it is stated that—

> "By the Brussels Convention, it has been agreed between the "Powers concerned, of which Great Britain is one, that all "home-grown sugar should be entitled to remission at the rate "of six francs per 100 kilos—equivalent, that is to 2s. 6d. per "cwt.—from whatever tax might be levied by the country of "its origin."

This is a curious mistake, as the Brussels Convention does nothing of the kind. All that it stipulates for is, that in no case shall a country which is a party to the convention allow its customs duty to exceed its excise duty by more than 2s. 6d.; this is a very different thing to stipulating that its excise duty must be 2s. 6d. less than the customs duty.

It may, I think with some certainty, be stated that, in the present state of public opinion, there is not the slightest likelihood of any Government reducing the excise duty in this country by 2s. 6d. below the customs duty.

I am, Sir, your obedient servant,

Nevile Lubbock.

20, Eastcheap, London, E.C.,
April 6th, 1904.

LIGHT RAILWAY CONSTRUCTION IN MAURITIUS.

To the Editor of "The International Sugar Journal."

Dear Sir,—Sometime during last year, you made allusion to the disease that in less than twelve months, destroyed practically every horse, mule, and ox in the colony, and thus wiped out completely all the means at planters' disposal to carry the then ripening crop, which has just been finished and has yielded well over 2,000,000 tons of canes, most of which had to be carried considerable distances. I do not think that people outside Mauritius have very much idea of what goes on inside it, or even, in many cases, of where it is, but it might interest some to know with what energy and pluck a small people in a small land set to work to face a situation which to say the least of it was serious, and if not remedied in time would infallibly have ended in disaster. At the end of the 1902 crop, in January last year, which itself had been carried with great difficulty, largely by coolies drawing carts—vice mules deceased—scarcely a draught animal was to be found in the whole island except a few carriage horses which

escaped probably thanks to scrupulous care and fine condition. Prices had been bad, and the crop under the average, and very few planters possessed the wherewithal to get their estates out with light railways, &c. Government came to the rescue and arranged to advance the necessary funds to estates that could show security for it, an offer of which nearly every estate took advantage. Orders were promptly cabled (the majority in March), special direct steamers were chartered to carry the material, immediately it arrived it was hurried off night and day as fast as the government railway could carry it to the various estates, and laid and got to work as rapidly as possible. Many places were ready to begin crop in August and the remainder in September with the new means of transport, of which I append a list. When one considers that most of it was not ordered till March, and that miles of cuttings and embankments had to be made, in very hilly and rocky ground, and bridges to be built (herewith copy of a photograph of one)*, surely it seems a creditable performance.

Yours faithfully,

GEO. W. MALCOLM.

Manager: FORGES ET FONDERIES DE MAURICE,
Port Louis, Mauritius.

Means of Transport.

	ENGLAND.		FRANCE.		GERMANY.		BELGIUM.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value
Light Railway Material	80 Kilometres.	£57,676.	17 Kilometres.	£12,313.	83 Kilometres.	£29,840.	257 Kilometres.	£85,351.
Locomotives	27		3		16		4	
Steam Lurries and Traction Engines	23		2		1		—	
Steel Wire Rope for Aerial Tramway..	131,000 ft.							

"WEINRICH'S NEW PROCESS."

TO THE EDITOR OF "THE INTERNATIONAL SUGAR JOURNAL."

Dear Sir,—In your March number an article appeared with the title, "Weinrich's New Process for Treating Sugar Cane with Lime." In the same number is a description by Mr. James M'Donald of a method of clarification in use at M'Bryde's factory, in Hawaiian Islands, which is practically identical with the "New Process" claimed by Mr. Weinrich.

* See frontispiece.

The process described by Mr. M'Donald was introduced into the M'Bryde factory by me, and has been used by me for the past ten years on the "Central Trinidad" in this island. The process was an evolution; Mr. J. George Lurmlins, the chemist of Trinidad Central, proposed using lime water on the crushed cane between the mills, for the purpose of avoiding the formation of vitrious slag formed in the furnaces or bagasse burners. It served this purpose, preventing this formation, and making instead a very friable slag easily removed. It was, however, also noticed that the juices expressed from the cane so treated were purified much more readily, and the only objection was the excess of alkalinity, which we easily overcame by passing the juices through a current of sulphurous gas, exactly as described so well by Mr. M'Donald in the January numbers of *Hawaiian Sugar Planters' Journal*."

Will you kindly insert this in your Journal, and oblige,

Yours truly,

Habana, Cuba, O. B. STILLMAN.

March 27th, 1904.

OBITUARY.

ANDREAS FREITAG.

We regret to have to record the death of Andreas Freitag, the well known Manager of the Wester-Suiker Raffinaderiy, Amsterdam, who passed away on the 11th inst. at the age of 52 years. His name was well known not only in the sugar industry of his country, but in that of the whole world.

A German by birth, born near Magdeburg, he entered, as an apprentice, an engineering works, rose to be engineer of the Maschinenfabrik Grevenbroich, and in this capacity came as erecting engineer to Amsterdam. His great zeal, energy, and hard work induced the proprietor of the Wester-Suiker Raffinaderiy to appoint him as works engineer. He was promoted from this position to one of Manager, and when his Firm became a Limited Company, he became Managing Director of the Company. The Raffinaderiy in Amsterdam is one of the most modern and most economically installed refineries, and people from all parts of the world sought after Freitag to have a talk with him and to see his place. He was always willing to explain anything, was amiable in his disposition, and friendly to everybody. He was not ashamed of his former humble position, from which he rose to becoming the recognised authority on sugar making and sugar refining. He was a friend to everybody and we do not think he had an enemy.

He worked very hard on his numerous inventions, indeed was often too sanguine about many of those he placed on the market; but admittedly several of them are of great value to the industry. At the end of the eighties he introduced the "Freitag vacuum pan," later on

the "Freitag process for the working up of after products," the "self-lubricating bearings," the "Freitag filters," and the "Freitag centrifugal machines." He took a great interest in the electrical process for refining of sugar, and when the writer visited him on several occasions, he was told that he had a strong belief that one day electricity would form an important *rôle* in sugar refining.

The sugar industry lost a great pioneer when he passed away, all too soon, after an illness which lasted for several years. He leaves a widow and three children to mourn his death.

S. S.

GIDEON POTT.

We regret to have to announce the death, very suddenly on the 15th April, of Mr. Gideon Pott, of the firm of Pott, Cassels & Williamson, Motherwell, Scotland.

PUBLICATIONS RECEIVED.

REPORT OF THE AGRICULTURAL WORK FOR THE SEASON BETWEEN 1901-1903 CARRIED ON IN BARBADOS. By Prof. J. P. d'Albuquerque and J. R. Bovell.

This is a voluminous foolscap pamphlet, of some 120 pages, dealing with the details and results of the agricultural work carried on in Barbados under the direction of the Imperial Department of Agriculture for the West Indies. Included in it is the report on seedling cane experiments published last Autumn, a summary of which appeared in our columns last December. This latest publication is mainly filled with tabulated results of work on 1,200 plots of canes, and we are glad to learn that at least 80 more tables, which were available, were omitted. As it is, there is quite a bewildering array of figures, and only those specially interested in the subject will attempt to wade through them. The value of the results attained from year to year appears to be sustained, and it is anticipated that in a few years definite conclusions will be available to guide the planter into the choice of the most suitable variety of cane.

DIE ZUCKERFABRIKATION (The Manufacture of Sugar). By Dr. H. Claassen. Second Edition. Schallehn & Wollbrück, Magdeburg. Price, Mk. 15.

This volume, by the well-known German authority, Dr. H. Claassen, first appeared in 1901. Its reception was evidently so encouraging that within two years a second edition had to be prepared. This has just been issued, and, in order to bring it up-to-date, no less than 40 additional pages have been inserted, to say nothing of alterations to the original text. This being so, the book should prove of as great value to-day as the earlier version was in its time. It supplies the same want to the beet sugar industry as Geerligs' "On Cane Sugar" has done in a less detailed form to the cane sugar industry.

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. Thompson, C.E., F.C.S., M.I.M.E., Chartered Patent Agent, 6, Lord Street, Liverpool ; and 322, High Holborn, London.

ENGLISH.—Application.

7089. S. Stein, Liverpool. *Improvements in the manufacture of invert sugar.* 24th March, 1904.

Abridgment.

26665. W. C. Salisbury and A. J. Kramper, Dakota, United States of America. *An improved process of obtaining syrup from beets, cane, corn, root crops, or other substances containing saccharine matter.* 5th December, 1903. The objects of the invention are in a ready, simple, thoroughly feasible and practical manner to eliminate the odour or flavour of the syrup inherent in the material producing it: to obviate fermentation and crystallisation: to improve the taste and colour of the produced product, and generally, to simplify and cheapen the procedure.

GERMAN.—Abridgments.

147225. August Neumann, Berlin and Friedrich Schroeder, Magdeburg. *Vacuum pans having internally arranged heating apparatus and circulation pipes.* November 5th, 1902. In order to produce a vigorous evolution of steam and an active rise of the liquid in the circulation pipe produced thereby in vacuum boiling down pans having an internal heating apparatus and circulation pipe, the heating apparatus is arranged at the bottom of a hood-like (preferably funnel shaped, globular cup, or the like shaped) enlargement which forms the lower end of the circulation pipe. As by reason of this arrangement the heating and evaporating is mainly transferred to the lower part of the circulation pipe, a vigorous upward movement of the heat takes place not only in the pipe, but it is assisted to a great extent by a very free evolution of steam in the hood or enlargement, and a compression of the bubbles of steam towards the neck of the enlargement thus producing an injector action directed towards the circulation pipe.

147443. Franz Berndal, Berlin. *A process and apparatus for utilising again the diffusion water.* January 25th, 1903. The waste waters in the diffusion process freed from fragments of shreddings and the like, are collected separately according to their saccharine contents with the object of re-utilising said diffusion waters, and again conveyed to the diffusion apparatus in such a way that the water which is richer in sugar is used for mashing, if desired mixed with used water from the press, whilst the diffusion water, which is poorer in sugar, is used for the pressing operation, if necessary with the addition of fresh water.

147576. Jules Charles Fernand Lafeuille, Cairo, Egypt. *A process and apparatus for obtaining concentrated juice from dried beet shreddings or shreddings of other saccharine plants.* July 2nd, 1901. The shreddings are introduced into a vessel filled with water, which serves as an extraction apparatus, and which in the course of the working has partly already received sugar in such a way that they first come in contact with the liquid which is richest in sugar moving in an opposite direction and then in accordance with their exhaustion and the upward movements of the shreddings resulting therefrom, with layers always poorer in sugar, and in proximity to the surface of the liquid, with pure water.

147627. Dr. H. Winter, Charlottenburg. *A method of making products resembling cane or colonial sugar from beet sugar.* February 28th, 1902. A similar taste and character to that of the genuine colonial or cane sugar may be imparted to beet sugar without the addition of cane sugar or cane molasses. For this object the sugar crystals are cased with a thin layer of syrup which contains for instance invert sugar or other hexose, alone or in conjunction with decomposing products obtained in the ordinary manner by decomposing a solution of invert sugar or other hexose, by boiling one or more times with soda lye, potash lye, or lime, until a slightly alkaline or acid reaction is obtained. These sugar sorts may be added alone or simultaneously with the said decomposition products during the treatment of the beet sugar solutions, or both kinds of substances may be produced in the beet sugar solution itself, by partial inversion and treatment with soda lye, potash lye, or lime.

147669. Metallwarenfabrik vorm. Fr. Zickerick, Wolfenbüttel. *An apparatus for separating the scum from the sugar juice and the like.* November 30th, 1902. The following arrangement is adopted for separating the scum from sugar juice and the like. The juice is introduced through an upper pipe into the separating vessel preferably in the first heater, and discharged through a discharge apparatus at a lower level. In order to maintain the juice in the vessel at a uniform level for the purpose of obtaining a more successful removal of the scum, a pipe is carried upwards from the discharge pipe, which pipe has an elbow at the level of the desired level of the juice. The juice entering by the first named upper pipe allows its scum to rise upwards whilst itself it is carried downwards, so that an extremely clean separation is effected. Mixing blades or arms are provided in the upper funnel-shaped part of the apparatus. The shape of the lower part of these arms is such as to suit the funnel or hopper and they are also in section inclined out of the vertical and rotate in a certain direction. The effect of this is that the scum accumulates in the centre from whence it leaves the apparatus through another pipe provided on the opposite side to the first named pipe.

147673. W. Bock, Prinzenthal, near Bromberg. *A vertically displaceable means for closing shredding presses for lengthening or shortening the pressing chamber whilst avoiding altering its section.* December 2nd, 1902. A perforated or non-perforated body surrounding the press spindle and adapted for closing the lower cylindrical part, is arranged in the mouthpiece in such a way that the lower edge of its cylindrical part in its highest position lies higher than the lower edge of the sieve casing which is contracted conically downwards, so that by pressing this closing device higher or lower, the pressing chamber may be shortened and the discharge opening enlarged or it may be lengthened and the discharge opening in the mouthpiece contracted.

147916. Hallesche Maschinenfabrik, Eisengiesserei vorm. R. Riedel and Kemnitz, Halle, a. S. *An apparatus for regulating the circulation of the liquid in evaporating and boiling down apparatus having heating surfaces constructed in stages.* January 30th, 1903. The heating surfaces which are constructed in stages and surrounded internally or externally, or internally and externally, by rings which act as circulation pipes and have the form of truncated cones so that by these rings the jet of liquid rising on the heating surfaces and necessary for each charging of the apparatus for heating the stages separately or as a whole, is guided separately from the masse-cuite which sinks downwards.

148353. Ludwig Lorenz, Dormagen. *A knife holder for beetroot shredding machines, adapted to be inserted into the knife holding disc from the top or the sides.* 1st April, 1903. The sides of the knife holder are provided with projections or notches which gear with notches or projections set at reverse intervals in the discs which receive the knife holders, so that the holders are supported along their entire length. When the holder is inserted in the disc, it is secured against being thrown out by catches acted on by a spring, in such a way that the projections press the catches by the springs into the notches of the disc.

Copies of all published specifications with their drawings in these lists can be obtained from W. P. Thompson & Co., 6, Lord Street, Liverpool, at One Shilling a copy for English or American Patents, and Two Shillings for German. In ordering please give number and date.

IMPORTS AND EXPORTS OF SUGAR (UNITED KINGDOM.

To end of March 1903 and 1904.

IMPORTS.

Raw Sugars.	Quantities.		Values.	
	1903.	1904.	1903.	1904.
	Cwts.	Cwts.	£	£
Germany	1,039,338	1,625,655	413,656	692,651
Holland	103,465	62,834	38,968	24,785
Belgium	259,911	56,627	107,091	21,661
France	71,216	45,353	32,967	18,920
Austria-Hungary	926,446	446,373	386,261	206,541
Java	....	365,318	....	159,119
Philippine Islands	70,646	....	25,285	....
Peru	45,414	223,304	16,849	98,156
Brazil	31,481	69,295	11,996	26,891
Argentine Republic	55,543	....	24,060	....
Mauritius	61,353	60,516	21,565	22,134
British East Indies	55,478	36,300	21,054	15,463
Br. W. Indies, Guiana, &c.	120,407	245,288	74,167	156,301
Other Countries	86,906	176,666	37,580	81,732
Total Raw Sugars	2,927,604	3,413,529	1,211,499	1,524,354
Refined Sugars.				
Germany	3,077,372	2,256,982	1,589,242	1,247,126
Holland	538,189	775,460	312,626	451,363
Belgium	33,212	101,767	19,320	56,669
France	191,927	568,640	113,221	302,890
Other Countries	286,530	151,346	142,049	79,659
Total Refined Sugars	4,127,230	3,854,195	2,176,458	2,137,707
Molasses	395,962	324,949	74,659	63,941
Total Imports	7,450,796	7,592,673	3,462,616	3,726,002

EXPORTS.

British Refined Sugars.	Cwts.	Cwts.	£	£
Sweden and Norway	5,438	5,944	2,841	3,415
Denmark	18,458	32,478	9,471	10,649
Holland	15,485	15,066	8,427	7,920
Belgium	2,265	2,701	1,100	1,512
Portugal, Azores, &c.	1,521	2,568	862	1,475
Italy	2,448	29,396	1,129	16,603
Other Countries	116,938	43,599	70,923	2[illegible],868
	162,553	131,752	94,753	164,507
Foreign & Colonial Sugars.				
Refined and Candy	5,495	6,429	3,826	4,514
Unrefined	10,052	23,479	5,332	12,450
Molasses	43	35	33	17
Total Exports	178,143	161,695	103,944	181,488

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1904. Tons.		1903. Tons.
Total Receipts, 1st Jan. to April 14th ..	550,918	..	452,153
Receipts of Refined ,, ,, ,, ..	75	..	252
Deliveries ,, ,, ,, ..	544,928	..	409,003
Consumption (4 Ports, Exports deducted) since 1st January	463,410	..	380,209
Importers' Stocks (4 Ports) April 13th ..	18,151	..	47,535
Total Stocks, April 27th	184,000	..	217,347
Stocks in Cuba ,, ...	245,000	..	359,263
	1903.		1902.
Total Consumption for twelve months ..	2.549,643	..	2,566,108

CUBA.

STATEMENT OF EXPORTS AND STOCKS OF SUGAR, 1903 AND 1904.

(Tons of 2,240lbs.)	1903. Tons.		1904. Tons.
Exports	178,676	..	454,278
Stocks	362,996	..	286,403
	541,672	..	740,681
Local Consumption (three months)	11,380	..	11,740
	553,052	..	752,421
Stock on 1st January (old crop)	42,530	..	94,835
Receipts at Ports up to March 31st ..	510,522	..	657,586

J. GUMA.—F. MEJER.

Havana, March 31st, 1904.

UNITED KINGDOM.

STATEMENT OF IMPORTS, EXPORTS, AND CONSUMPTION FOR THREE MONTHS ENDING MARCH 31ST.

SUGAR.	Imports. 1904. Tons.		Imports. 1903. Tons.		Imports. 1902. Tons.	Exports (Foreign). 1904. Tons.		Exports (Foreign). 1903. Tons.		Exports (Foreign). 1902. Tons.
Refined	192,709	..	206,361	..	396,223	321	..	275	..	421
Raw	170,676	..	146,380	..	284,758	1,713	..	502	..	800
Molasses	16,427	..	19,798	..	15,592	2	..	2	..	41
Total	379,632	..	372,539	..	696,573	1,496	..	779	..	1,262

	Home Consumption. 1904. Tons.		1903. Tons.		1902. Tons.
Refined..	203,712	..	193,834	..	401,050
Raw	26,548	..	132,159	..	302,243
Molasses	20,495	..	17,800	..	16,776
Total	250,755	..	343,793	..	720,069
Less Exports of British Refined.....................	6,587	..	8,127	..	8,310
Home Consumption of Sugar imported from Abroad..	244,168	..	335,666	..	711,759
,, ,, ,, Refined (in Bond)......	124,153	..	—	..	—
,, ,, Molasses, manufactured (in Bond)	16,611	..	—	..	—
Total Home Consumption of Sugar	384,932	..	335,666	..	711,759

Stocks of Sugar in Europe at uneven dates, April 1st to 27th, compared with previous Years.

In thousands of tons, to the nearest thousand.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	Total 1904.
106	1178	743	476	264	2770

	1903.	1902.	1901.	1900.
Totals	2722 ..	2857 ..	2172 ..	1971

Twelve Months' Consumption of Sugar in Europe for Three Years, ending March 31st, in thousands of tons.

(From Licht's Monthly Circular.)

Great Britain.	Germany	France.	Austria.	Holland, Belgium, &c.	Total 1903-4.	Total 1902-3.	Total. 1901-2.
1696	940	647	443	510	4236	3675	4187

Estimated Crop of Beetroot Sugar on the Continent of Europe for the current Campaign, compared with the actual crop of the three previous Campaigns.

(From Licht's Monthly Circular.)

	1903-1904. Tons.	1902-1903. Tons.	1901-1902. Tons.	1900-1901. Tons.
Germany	1,950,000 ..	1,762,461 ..	2,304,923 ..	1,984,187
Austria	1,175,000 ..	1,057,692 ..	1,301,549 ..	1,094,043
France	780,000 ..	833,210 ..	1,123,533 ..	1,113,893
Russia	1,200,000 ..	1,256,311 ..	1,098,983 ..	918,838
Belgium	210,000 ..	215,000 ..	334,960 ..	333,119
Holland	125,000 ..	102,411 ..	203,172 ..	178,081
Other Countries.	410,000 ..	325,082 ..	393,236 ..	367,919
	5,850,000	5,552,167	6,760,356	5,990,080

THE

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☞ The Editor is not responsible for statements or opinions contained in articles which are signed, or the source of which is named.

NOTES AND COMMENTS.

Messrs. Blyth Bros. & Co., Mauritius, report shipments of sugar from August 1st to April 16th, at 159,961 tons, as compared with 116,182 tons for the corresponding period of the previous season. It went chiefly to India, the Cape, and the United Kingdom.

The Sugar Industry in Java.

We have pleasure in drawing attention to the first part of a paper by Mr. H. C. Prinsen Geerligs on the Sugar Industry in Java, which appears in our Journal this month. In his admirable series of articles on the same subject, which were published in the *Sugar Cane* in 1897 and afterwards reproduced in book form, Mr. Geerligs dealt exclusively with the factory work in the manufacture of sugar, and did not enlighten us regarding the agricultural procedure. He now supplies this omission. Though not of such length as his former papers, this last article from his pen will be found an interesting and valuable contribution to the information available on the high class methods adopted in Java for turning out sugar of the best quality. Incidentally, he disposes of the idea that Java is an exceptionally favoured country for sugar cane culture, and shows that as a matter of fact, only hard scientific work will now enable a profit to be made. Dear land and ravages of disease are ever present factors to be considered, and the one redeeming feature is a plentiful supply of cheap labour. Otherwise the energy of the planters and the technical skill of the factory experts alone account for the success attained.

Indian Duties on Sugar.

The Board of Trade have received, through the India Office, a copy of a Customs Circular (No. 6 of 1904), imposing from 1st April, 1904, the following *special* duties upon sugar imported into British India from the undermentioned countries:—

Countries.	Kinds of Sugar.	Rate of Special Duty per cwt. Rs. a. p.
Denmark..	Candy and sugar in whole or broken leaves, plates, cakes, &c., whatever the colour may be, and white pulverised sugar which is lighter than the Amsterdam standard sample, No. 18	0 8 10
Argentine Republic ..	Refined sugar	5 7 5
	Unrefined sugar	4 0 8
Russia..	Refined sugar	9 10 2
	Unrefined sugar	5 15 10

The present Customs Circular provides that the above duties are to be imposed whether the sugar is imported directly from the country of production or otherwise, and whether imported in the same condition as when exported from the country or has been changed in condition by manufacture or otherwise.

ASSOCIATION DES CHIMISTES DE SUCRERIE ET DE DISTILLERIE DE FRANCE.

Congress at Paris.

The Paris Congress of the Association des Chimistes de Sucrerie et de Distillerie de France took place on the 8th and 9th of March last. The first day was occupied in paying a visit to the General Agricultural Conference, and in going to hear M. Becquerel, member of the Institute, on the radio-active property of matter.

The second day was given to the reading of papers, and their discussion. The presidential address was given by M. Barbet, and mainly indicated the practical means at one's disposal for increasing the home consumption of sugar. He instanced in the first place the methodical use of sugar in culinary products; omelets with jam or sugar, vegetables with sugar, even certain spiced meats, slightly sweetened, specially called for attention, and he thought, no doubt reasonably, that the adoption of such condiments would create as great a demand on the sugar industry as do cakes and biscuits. To facilitate such a movement, M. Barbet advised the fabricants to establish popular restaurants for dealing in sugared confections, in

which should be served moderate-priced dishes, as would, carefully calculated by chemists, restore the normal balance between the elements of nitrogen and hydro-carbon in human food, a point rarely considered. A "national" sweet beverage, and particularly a *bon vin chaud*, would complete this alimentary régime, the precepts of which should be diffused not only by such restaurants but also by popular pamphlets on a large scale. Such a proposal in its conception might seem out of place on the programme of the Association, but M. Barbet thought that the latter could not fail to be interested in present day economic problems dealing with the sugar works and distillery. From the same point of view, in order to obviate any reduction in the beet sowings, he counselled the combining of a distillery with the sugar factory, so as to have the option of producing sugar or alcohol, as might prove the most advantageous.

Sugar Manufacture.

M. L. Lindet gave an account of his recent investigations "*on the causes which effect or retard the auto-inversion of sucrose.*" It is now known that this phenomenon (transformation of sucrose into glucose and levulose by water at 100° C. without any addition of acids or salts) is due to the slightly acid properties of sucrose and to the more pronounced acid properties of invert sugars. M. Lindet has established this fact by numerous experiments, of which he gave a very interesting account. He measured the state of electrolytic dissociation of the different sugars in solution, *i.e.*, their electrical conductivity; and showed that in a glass vessel the inversion is diminished owing to the fact that the alkalinity of the glass saturates the acidity of the sugar; certain metals (copper, lead, tin, aluminium, &c.) promote inversion by forming hydrates which yield up a molecule of water to the sugar and are then rehydrated; certain other metals (silver, platinum, mercury, &c.) are indifferent, because they do not form hydrates; whilst others (iron, zinc, magnesium, &c.) retard inversion by forming alkaline hydrates. The active metals, besides promoting inversion, possess other very distinct properties; since the heat given off in the formation of their compounds is very small, and the tendency to chemical dissociation is very great; their action is the more marked as their combinations are less sensible to electrolytic dissociation, yielding less heat during ionisation and having less tendency to electrolytic decomposition.

Have M. Lindet's researches any practical bearing on the sugar industry? The author does not think so; but they confirm principles which practice has sought to establish. They show, for example, that the factory should always keep the juice and syrups alkaline, not so much to avoid their becoming acid, as to prevent them becoming neutral, for in the presence of certain salts and metallic acids auto-inversion takes place. The syrups if aerated become more hydrated in

the presence of copper and inversion would follow. It is desirable to evaporate the juice and boil the syrups immediately after clarification without allowing them time to absorb oxygen from the air and, as a consequence, to produce cuprous hydrate by contact with the tubes of the triple effet or the spiral coils of the vacuum pan. It might be remarked in conclusion that the addition of soda salts in second carbonatation is justified as an excellent plan, because the compounds of soda and organic acids are less dissociable than the corresponding lime compounds and consequently less active in promoting inversion.

M. Lindet however thinks that numerous phenomena appearing in the manufacture of saccharine products could be explained by these experimental facts just given, and that one could deduce therefrom many interesting and practical conclusions. For example, it is known that the addition of a little invert sugar during the cooking of preserves retards the crystallisation of the sucrose which occurs only after a considerable period. Long boiling in a copper pan or the addition of a minute and harmless proportion of copper, say a millionth part, produces the same result.

M. Besson, professor in the University of Caen, gave some account of experiments undertaken in his laboratory and with laboratory apparatus, "*on the comparative results of different diffusions.*" These experiments are, doubtless, still incomplete, notably those treating of the working up of frozen roots; they were, however, justly worthy of communication to the assembly. The frozen beets ought to be worked up immediately, any delay involved the production of juice of lower purity and liable to decomposition. The process of diffusion has been studied, in the presence of different chemical reagents, treating pulp obtained from a beet slicer. The purity of the raw and carbonated juice decreases appreciably when the proportion of ammonia in the diffusion water increases, even if one takes the precaution of keeping the juice neutral during carbonatation and diffusion; with pure tri-methylamine, on the other hand, the purity is slightly increased; but where the juice retains ammonia, its purity diminishes. The use of bisulphites has been a special object of Professor Besson's studies. The bisulphite solutions employed (sodium, calcium, aluminium), having the same concentration as the solutions employed in diffusion, were from one to two per 1000 volumes of a commercial solution of bisulphite of soda of 30° B., and the other bisulphite and sulphurous solutions were taken of an equal acidity. The raw juices treated were less coloured and had a purity equal to that of the aqueous diffusion juice and did not yield more invert sugar, within the limits of an acidity of 0·4 gr. SO_2 per litre. The carbonated juices were slightly less coloured and in general somewhat purer, but lime salts were more abundant. The employment of bisulphites or sulphurous acid, if really needful from an antiseptic point of view during diffusion, can have no effect under these conditions on the chemical quality of

the juice. The sodium and calcium bisulphites seem the best from a chemical standpoint, but, having regard to the fact that nearly all factories possess apparatus to produce their own sulphurous acid, it is apparent that the employment of sulphurous solutions in doses of 0·2 gr. to 0·4 gr. SO_2 per litre will prove the most economical.

M. Besson also remarked that carbonic gas dissolved freely in the cossettes and was afterwards evolved during diffusion whereupon the purity of the juice diminished; the same holds good in regard to the purity and the saline quotient of the carbonated juice; the lime salts are increased. Are not these results, M. Besson asks, connected with the preservation of the roots in the silos, the atmosphere of which is saturated with carbonic acid gas evolved during the period of retarded life of the roots? This would certainly explain the abundant liberation of gas during diffusion. For this reason the ventilation of the silos, some time before the roots are to be worked, seems desirable. It is a pity that this question was not further discussed by the meeting.

M. Aulard defended before the Association one of his favourite views, which he has already ventilated in his report at the Berlin Congress: *On hot and cold liming of juice; and the influence of duration of contact of the juice with lime.* Contrary to what is extolled by MM. Prangey and de Groubert as giving the maximum useful effect, M. Aulard recommends cold liming of diffusion juice, and as long a contact of the lime with the juice as is possible under practical and industrial conditions. In this manner he obtained with gradual heating to 70° C., a limpid, colourless, and very pure juice, as well as dry and compact filter press cake, containing little sugar, but he considered it worth while appealing to the opinion of a more competent authority to settle the ever recurring question, as to the best method of utilising the lime; the laboratory officials of the Syndicat des Fabricants de Sucre de France seemed to him the most suitable persons to undertake this. Some remarks were here offered by Messrs. Besson, Sellier, Fabre Guillaume, &c. M. Besson's laboratory experiments tended to condemn the prolongation of contact of the lime with the juice and showed that hot and cold liming had nothing in common. M. Sellier wished to settle the question from the standpoint of the nitrogenous matter, and he stated that, from his experiments, there was some risk in leaving limed juice in contact with coagulated albuminoid matter at 80° C. for too long a time. M. Guillaume repeated the statements made by him in 1872-3, and in 1875, proving that the fermentation of the beets in silos results in the production of juices which must be worked up as quickly as possible. But there was a great diversity of opinion on these points.

M. Weisberg read a paper entitled: *A practical study of the employment of sulphurous acid in the sugar industry.* He began by recounting the history of this important question, and then made a critical survey of the processes actually in vogue in the sugar factories,

and pointed out their imperfections and drawbacks. He finally gave an account of his experience with sulphurous acid, and of the researches which had gradually led him to elaborate the process known as "sulphi-carbonatation," of which he explained the scientific principle and described its *modus operandi*. Well carried out, sulphi-carbonatation has the following principal advantages, all of which are confirmed by the experiences of various usines which have adopted the process. 1. A more perfect decoloration of the products than by any other of the processes in vogue which employ sulphurous acid. 2. Easier filtration and washing of the scums of first carbonatation when mixed with those obtained by sulphi-carbonatation. 3. Easier evaporation without frothing, the juice being more liquid, and the boiling point slightly lower. 4. More rapid pan work, giving in first and second jets a very fine grain, of regular shape, an increased yield per hectolitre of masse-cuite, and a higher output in general, the molasses resulting from this work being more exhausted; the possibility of returning into the wash a very large quantity of rich runnings while turning out beautiful refined sugar. 5. All the products of this process possess a distinct alkalinity to phenolphthalein and can be stored without undergoing any deterioration. 6. Simplification of the work by suppressing the sulphuring of the syrups (or in some cases of two operations in such usines as sulphur twice) the rich runnings from the sulphi-carbonatation requiring no further treatment with sulphur in order to obtain a good crystallisation.

M. Weisberg found an excellent supporter in M. Aulard, who certainly did not desire to oppose his process of "barytic sulphitation" to that of "sulphi-carbonatation," and he added that the latter process had funished him with excellent and "almost marvellous" results, in the trial he had made of it at Marche; he had no hesitation in recommending its adoption especially in new installations and was assured that, under good working conditions, an absolute decoloration would be obtained.

M. Besson made a short communication on *The influence of alloys of Aluminium in preventing the formation of "scale" during concentration of the juice.* He first of all gave a resumé of the previous conclusions regarding the influence of aluminium alloys on the decoloration and purification of the concentrated syrup and he specially emphasized the conditions necessary to prevent scale formation either in the case of lime, or more frequently of siliceous, deposits. M. Besson following up his theories with a practical demonstration; he placed before his audience large flasks which had served to carry out comparative concentrations, with and without alloys, of ordinary carbonated juice and of juice rendered siliceous by the addition of silicate of soda at the end of the second carbonatation. There is no need, said he, to use a lens to see the contrast between the two flasks. The reagent—the composition of which the inventor preferred not to

divulge—had been employed in the proportion of 0·2 gr. per litre of juice, but one has to bear in mind that the experiments were carried out in a laboratory, and that, under such conditions, the deposits are three, four, or even five times as abundant as in the usine, where an addition of one gr. per hectolitre would suffice. The deposits however maintained in either case the same character—provided that the alloy was finely pulverized, the juice sufficiently alkaline, and, in brief, that the Besson process was suitably applied.

M. Besson demonstrated that the manufacture of the alloy was commercially possible; a finely powdered sample on being thrown into a glass of water immediately gave rise to an abundant discharge of gas; but each particle became coated with a white film of alumina which only disappeared rapidly—an indispensable condition in this process—when the juice has an alkalinity of about 0·2 gr. per litre. This alkalinity precipitates the alumina in the form of silico-aluminate of lime, which is granular, as "soft as talc," and non-adherent; whereas silicate of lime deposited in a flask is gelatinous and very adhesive. M. Besson modestly declared that he would not insist upon the working of normally alkaline juices in the factory; he had, however, been led to the discovery of a still more economical process than the preceding, and which gave equally good results without requiring the juice to be alkaline. The description of this new process would probably be included in the programme of the next Congress.

M. Vivien read a paper containing an important communication which had appeared the same morning in the *Journal des Fabricants*, entitled: *The Crisis of the Sugar and Agricultural Industries—Causes and Remedies.* We cannot here summarise or criticise it; but its conclusions are in favour of an increase in the production of sugar and in the cultivation of the "extra-rich" beet, yielding the maximum return per hectare. M. Vivien also advocated a rebate from all duties on sugar employed for other purposes than human food, a progressive reduction on those on sugar used for consumption, and finally the creation of new outlets for sugar (military rations, bonbons, biscuits, preserved fruits, condensed milk, powdered milk, chocolate, syrups, &c.).

M. Aulard, always amiable, congratulated M. Vivien on his paper, and then declared that he had not found in it the real remedies for the sugar crisis. He could not agree with the indecisive conclusions shown in the report of M. E. Saillard, on the agricultural work of the Syndicat des Fabricants de Sucre de France. From the agriculturist's point of view, M. Aulard did not believe that salvation lay in the cultivation of the "extra-rich" beet, since the Germans themselves no longer adopted it. In Belgium a beet of medium richness most frequently gave the heaviest return of sugar per hectare; and he would prove this by trials he proposed to undertake during this season. From an industrial standpoint he thought the fabricants should first seek for a remedy in connection with cattle food.

The Belgian Government had realised this so well that it had authorised, for the purpose of cattle feeding, the sale of after-products indemnified from all duty when denaturated by a simple method (3% of chloride of soda, 10% of wheat bran, and 87% of sucrose). The same Government, always on the alert, and regretting that the consumption duty had been fixed at 20 fr. instead of 15 fr. as promised by them, had granted a rebate to the manufacturers of invert sugar of a quarter of the duties collected; this had allowed the breweries to buy at a reasonable price a very pure invert sugar cheaper than the glucoses hitherto employed and in every way more suitable for their work. The same Government had likewise given a rebate on sugar used to make alcohol. M. Aulard advised his French colleagues to bring round their own Government to granting this latter concession; he said all the after products which were easily denaturated with spent wort, could go to this distillery, allowing in the course of a day's work a profit of 11 fr. or more per 100 kg. (basis 75),—from which would have to be deducted the costs of transport, manufacture, &c.,—and in this way the considerable stocks of sugar would immediately tend to diminish.

The figures showing the yield of alcohol from after products of the sugar works, as given by M. Aulard, were deemed by M. Barbet to be exaggerated; the latter estimated the return to be from 60 to 60·5 litres instead of 63 litres. He also thought that the molasses from second jet might be used in the distillery with advantage, and that the authorities would not object to this arrangement. M. Brunehant, regarding the question from the standpoint of the agriculturist, considered that M. Vivien held the correct view in advocating the production of a richer beet, and that any return to the old policy would be dangerous; he laid stress on the results of trials carried out by the *Syndicat,* in which the average return in sugar per hectare had been very similar in the case of both medium and rich sugar beets, and he thought that the seed-selecters had often been led astray in the choice of subjects. Dealing with this last matter, he concluded with an appeal to the manufacturers and chemists whom he advised to obtain as seed-bearers such plants as contain individually the maximum grammes of sugar. M. Ragot supported M. Brunehant's contentions; he thought M. Vivien's optimism was exaggerated, and he had possibly too much neglected the economical and commercial aspects of the question. M. M. Sellies and Lambert agreed with the principle enunciated by M. Brunehant as regards selection, and they affirmed that the question was much more advanced than he seemed to believe. Certain German and French houses had been working on these lines for some time past.

M. Naudet delivered quite a lecture—much too short, considering its interest—on the sugar industry in the United States. In 1889 and 1890 two usines were successively erected in Nebraska by the

Carion Delmotte Company. Afterwards the Pacific Coast in California became the scene of operations, where the beets gave 18·20 per cent. or more of sugar. The cultivation of the beetroot was next taken up in Michigan, where factories speedily multiplied, in Colorado, in Utah, in Idaho, &c. In Michigan the roots contained 14 to 14·5 per cent. of sugar; in Colorado they got 17 and 18 per cent.* of sugar with yields of 40,000 to 50,000 kg. per hectare. According to M. Naudet, the development of the sugar factories in U.S.A. depends mainly on the consumption. According as the production of Cuba does, or does not, enter the States, they will be able to produce a million tons more sugar from beets before being obliged to limit production, without which latter it would be necessary to resort to exportation, and thus lose the benefits of the bounty. Under such conditions will it be possible to dispense with the bounty? Not under existing conditions; but the old usines are being transformed, thanks to the efforts of the engineers of the American Sugar Refining Company; the consumption of coal, which is still generally excessive (from 180 to 240 kg. per long ton), will be reduced; attempts will be made to increase the yield, which is at the present day too low; processes for extracting sugar from the molasses and for drying the pulp will be introduced; the industry will therefore be able to flourish in regions where the beets contain approximately 17 per cent. of sugar.

As a matter of fact, one can point to several new factories which are perfectly designed; the factory of Fort Collins (Colorado) in particular is splendid; the uniformity and details of the installation leave nothing to be desired; the power is transmitted to the pump set by belts from a central shaft. "This appears incredible," said M. Naudet, "when, as in France, electrical force is largely adopted for driving the centrifugals, so as to effect the greatest possible economy of fuel." But in spite of these transmissions and belting, not a single difficulty in the progress of the work arises.

M. Naudet concluded by describing, in a graphic way, several very interesting features: special methods of transmission; the employment of clutches which dispense with free and fixed pulleys, permitting the starting of such machines as the washers, slicing machines, &c., to be as gradual as desired. Such appliances enable the American factories to work on automatically, and with a perfection unknown in the best French usines.

Finally M. Naudet referred to the difficulties met with in the working of Colorado beets which contain much more salts than the European roots. The diffusion of saline impurities being more rapid than the diffusion of sugar in the cold, it follows that the densest juices which are at the top of the diffusers or macerators are, contrary to what occurs in France, very impure. In this

*The "Sugar Beet" questions the accuracy of these figures.

case one cannot argue *a priori* that the densest and hottest juices in the battery are the purest. M. Naudet has hence been led to somewhat modify the process of diffusion and to conduct the work very rapidly in order to avoid too long a contact between the pure juice and the chips, or at all events, to reduce the duration of contact to a minimum.—(J. Troude in the *Journ. des Fab. de Sucre.*)

SCIENCE IN SUGAR PRODUCTION.

By T. H. P. Heriot, F.C.S.

(*Continued from page 221.*)

3. Labour-saving Machinery.

The very similar methods of transport adopted in the cane and beet industries do not require special mention, we may therefore proceed to review the mechanical methods of cultivating and harvesting the crops, considering these under:—Agricultural implements, harvesting machinery, and unloading arrangements at the factory.

The Beet.

(a) *Agricultural Implements.*

Engineering science has been an important factor in the economic aspects of beet-cultivation for, wherever manual labour could be avoided, mechanical methods of cultivation have been adopted.

Ploughing.—Before the development of the beet industry on the Continent, the soil was cultivated to a depth of only some 8 or 9 inches, the underlying subsoil remaining inert and unfertile. We have already remarked that the beet requires a deeply cultivated soil to allow the growing root to freely penetrate to a considerable depth. Any resistance to this downward growth tends to deform the root, rendering it difficult to harvest, and also to cause the root to grow above the ground-level, resulting in an inferior quality of the juice in the exposed area.

The first object of the beet grower was, therefore, to thoroughly loosen the subsoil, by which treatment its physical structure and chemical composition may be so far modified as to render fertile that which had hitherto remained inert and unproductive.

The more fertile surface-soil has been rendered so by constant exposure to the weathering action of air and rain, as also to the solvent action of gases arising from decomposing vegetable matter, upon the mineral debris of which all soils are composed. The lower strata, or subsoil, may contain the same chemical elements as the surface-soil, and yet remain barren, because, at this depth, the soil is not disturbed by the various operations of the cultivator, and therefore remains unexposed to atmospheric influences.

The subsoiler, which may either be attached to, or follow, the plough, loosens the stiff strata underlying the furrow turned over by the latter. Very gradually, this aerated portion of the subsoil undergoes oxidation, or is weathered, so that what was formerly unfertile land becomes an available supply of valuable plant-foods.

At long intervals of time, a deeper furrow is cut by the plough, thus turning over a small portion of the previously aerated subsoil, which henceforth forms part of the surface soil. Simultaneously with this deeper ploughing, the subsoiler is set to work at a greater depth so that a lower strata of inert subsoil is loosened and pulverized, to be subsequently turned over by the plough after thorough aeration. These successive operations must be very gradual, otherwise the surface land is impoverished by the addition of the less fertile subsoil. Thus, on lands under beet cultivation on the Continent, the combined use of the plough and subsoiler has extended the depth of fertile surface soil by nearly a foot during the course of 20 years.

Multiple ploughs, cutting from two to four furrows at a time, have almost completely ousted the old single-furrow implements, and have been brought to a high state of perfection. The double-furrow plough of the "Brabant" type is largely adopted in France.

The invention of the steam-plough has introduced another important advantage, for, whereas the draught-plough travels at about two miles an hour, the steam-plough covers as much as six miles in the same time. In addition to this economy, there is an increased efficiency in the work done; the furrows being more thoroughly broken up by the plough-share in rapid motion. Steam-ploughs are in general use in the beet industry, and are operated day and night.

Manuring.—The broadcast distribution of manures by the earlier machines has been abandoned in favour of the modern practice of manuring "in line," although the latter machines are both complicated and costly.

Of German machines, Dehne's comprises two distributers mounted on either side of a single wheel. The machine is pushed along, between the rows, like a wheelbarrow, the motion of the wheel actuating the distributers through suitable gearing. The manure is discharged through four hopper-tubes and deposited on either side of each plant, thus working two rows at a time.

Other machines deposit the manure "in bands" by means of small paddles revolving beneath the nozzle of each hopper-tube.

When the fertilizer has to be applied along with the seed, the two operations are effected by one machine, which drills and manures several rows simultaneously.

Drilling.—Many ingenious machines have been designed for drilling the beet-seed, some of these can be adjusted for any width of row; for drilling as many as ten rows at a time; and for working

on level or hilly ground. These machines open up the drill, drop in the seed, mixed with a little superphosphate or other fertilizer, and finally cover the drill with an inch or two of soil; these several operations being performed automatically whilst the machine is in motion.

The older and simpler type of machine deposits the seed in a continuous line along the drill, but the modern practice in France and Belgium is to sow "in pockets," a method devised by Max le Docte as far back as 1843. Comparative trials have shown that the latter method economises 50% of the seed formerly required for sowing "in line," the gain fully compensating for the cost of the special machinery required for this work. The distance between adjacent "pockets" is adjusted to correspond to the distance desired between the mature roots, and varies with the nature of the soil and quality of roots grown.

When the seedlings vegetate, showing two pairs of leaves, the roots are thinned out by removing those of less vigorous growth, and leaving single and healthy roots at the required distances; this work has to be done by hand, and is easily performed by children.

Hoeing and Weeding.—These important operations have to be several times repeated during the early development of the beet and, in order to prevent any injury to the young plants, are generally done by hand.

(*b*) *Harvesting Machinery.*

The costly work of lifting the roots by hand has led many inventors to design beet-harvesters with some degree of success. From 1867-72 the model was a subsoiling plough following behind an oblique plate or "pulsator," designed to press the crown of the root laterally, leaving it sufficiently loosened for the plough to lift. In 1873, the model, for operating two rows, consisted of two sub-soiling shares arranged tandem, and pressing on reverse sides of the roots, which were thus raised without being laterally displaced. The 1876 model was similar to the preceding, but provided with a guiding trolley in front.

From 1876 and after the enforcement of the law of 1884, which led to a change in the methods of cultivation, several modifications were introduced and, in 1895 a prize was awarded by the Concours International de Cambria for a harvester mounted on heavy wheels. These mechanical harvesters would operate one hectare in 40 hours, as compared with from 110 to 130 hours by manual labour, using a fork or spade. By the latter method it is estimated that fully 5% of the roots are damaged, resulting in an inferior quality of juice when the roots are subsequently worked up in the factory.

It appears, however, that a practical solution of this mechanical problem has not yet been reached, for a large German Sugar Society has offered a prize of 10,000 marks for a successful design to be submitted by the 15th July of the present year.

In France, the harvesting is almost entirely by hand, the roots being first loosened and slightly raised by means of a special form of fork.

Great progress has been made in America in the designing and construction of similar machinery, and it is therefore not surprising to learn that the Johnson Harvester Company, of New York, have perfected a machine which is now coming into general use in the American beet-sugar industry. The roots are dug, lifted from the soil, the foliage removed by a revolving cutter, and the topped roots dropped at the side of the row, ready for the factory or the storage silo; these operations being performed automatically as fast as the team of animals can haul the machine.

The roots, when drawn from the soil, are loaded by hand into carts or trucks for transport to the factory or storage-shed.

The Cane.

(a) *Agricultural Implements.*

Manual labour, in all departments of field-work is a distinguishing feature of the West Indian sugar industry, and is accounted for in two ways.

First, the long established system of open drainage, which offers serious obstacles to the transport of machines, and the necessity of which is most apparent in British Guiana where, owing to the uniform level and the silting property of the clay soils, tile-drainage has proved impracticable. The shallow navigation trenches of the same Colony present further obstacles in the way of transporting such heavy machinery as is required for steam-ploughing.

Turning to the Islands where the cane is cultivated on more or less elevated and undulating lands, we find the same antiquated methods adhered to, if we except the occasional use of light ploughs on the more level areas.

It is therefore of interest to record that steam-ploughing has recently been adopted by the Trinidad Estates Company, at a somewhat lower cost per acre than by animal-ploughing, and at about six-tenths of the cost of hand-forking. The steam plough does more efficient work, turning up the whole depth of surface-soil on these heavy clay lands in Trinidad, even during the dry season, when the former methods of tillage would be impossible. The main advantage to be gained may therefore be looked for in an increased tonnage of cane per acre when the newly ploughed lands are eventually cropped.

Messrs. Fowler, of Leeds, who supplied the machinery, estimate that fully 75% of the undulating lands under cane cultivation in Trinidad could be successfully worked by steam ploughs; the engines moving along the ridges, and the ploughs travelling across the valleys.

Following the plough we might hope to see other cultivating machinery introduced, but we here meet with a second objection, namely, that the present dependence on manual labour for reaping

the cane crop requires that a maximum of such labour must be somehow employed on the estate all the year round, in order that it may be available when required.

In criticising Mr. Lamont's article on "The West Indies, a Warning and a Way," an experienced planter in British Guiana has stated* that:—"labour-saving appliances have been adopted whenever they have proved to be cheaper than manual labour." But, from the context, this statement appears to be based on the wages paid to the coolie, whilst the heavy expenses of imported labour are ignored.

(*b*) *Harvesting Machinery.*

Briefly stated then, the absence of labour-saving appliances in the cultivation may be traced to the want of a Harvesting Machine, which has so far baffled the brains of inventors. The first step towards a practical solution of this problem would appear to be to secure an erect growth of cane, but as an irregular growth is regarded as a peculiar property of the cane which cannot be modified by the planter, this important problem has received no serious attention. The erect growth of some of the new seedling varieties should give a new impetus to this branch of engineering science.

Under existing conditions, in the West Indies, the coolie's cutlass reaps the canefield, and his head carries the cut cane to the cart, punt, or railway truck. The only labour-saving device in the field is a simple derrick for transferring small cartloads of cane to the railway truck. These have been adopted at loading stations on some of the larger estates in Trinidad within the past five years.

We have therefore to look elsewhere for improved methods of handling the cane crop, and, departing from our original programme, we shall describe some inventions which are being worked out in other cane growing countries. Many of these are yet in an experimental stage, but the desirability of future progress along these lines requires that mention should be made of such machines as have been actually tested.

Of portable cutters, those of *Paul* and *Lewis* hail from Queensland, and are manufactured in the States. The former employs an oscillating knife, the latter a broad chisel. Both cutters are driven by compressed air from a portable compressor, and are stated to operate at from three to four times the speed of the cutlass. It is difficult to see how such hand-machines can compete with the cutlass, in as much as the latter requires no careful adjustment against the cane stem and severs the stem at a single blow.

Of machine cutters, the following four inventions may be mentioned:—

1. *Le Blanc.*—Designed to cut, strip, and top the cane ready for the mill.

* This Journal, October, 1902, p. 527.

2. *Dupoy.*—Cuts two rows simultaneously, and has devices for raising prostrate cane. The canes are topped by rotary knives, the height of the cut being controlled by the operator.

3. *Gaussiron.*—A description, with illustrations, of the improved form of this machine appeared in "The Louisiana Planter" for April. It has two rotary cutters in front and travels on four wheels, the machine being propelled from behind by four mules harnessed to a central shaft. The machine cuts two rows of cane, leaving same in continuous rows on the ground.

4. *Smith.*—Several cutters driven by steam or electricity. On Plantation Qunaba, Bundaberg, the speed of working was 22 stems in ten seconds, or about 20 tons per hour.

The following four inventions refer to loading the cut cane into carts or trucks for transport:—

1. *Wright*, of Louisiana, has designed two loaders on the derrick principle, one being operated by steam power, the other by means of a counterpoise weight. His steam derrick employs a large mechanical rake for bringing the scattered canes into a heap, after which a grapple, suspended from the derrick, is lowered and clutches the collected cane between a pair of curved forks, the latter being centrally hinged. The grapple is operated by two ropes passing over the extremity of the derrick and coiled on two drums; one rope causing the open grapple to descend, the other closing and elevating the grapple and its load. Finally, the grapple is swung round over the loading cart and the load released. It is constructed to lift a maximum load of half a ton, lifting and dumping the load in 30 seconds, and requires three attendants. It costs about £200.

His smaller machine has the same hoisting tackle, but is operated by a counterpoise weight which slides upon the free end of the lever beam. The mechanical rake being dispensed with, the canes have to be collected in heaps, by hand, which actual trial indicates to be more effective. Experiments at Audubon Park are said to have fully demonstrated that these machines will load cane at a cost of less than three cents per ton. This model costs about one-third of his steam loader.

2. *Lotz.*—This machine is similar to the preceding, but with mule power for hoisting the load. It requires the attendance of four men and one boy, and has a loading capacity of from 80 to 90 tons of cane per day.

3. *Howard* has designed three derrick loaders. The first, or 1902 model, requires the cane to be previously collected into separate bundles, which are picked up by means of a sling attachment.

The 1903 model collects the scattered canes, during transit, by means of a special form of grapple attached directly to the derrick beam, the raising and lowering of the grapple being caused by the motion of the beam itself, which is hinged to the trolley.

The grapple consists of two pairs of forks, the lowermost being straight, and fixed so as to project from the extremity of the beam, parallel with same; the upper fork has curved ends, and hinges upon the lower fixed fork, the two forks being opened and closed by means of a catch operated by a cord.

The complete loading machine consists of a wide platform mounted on a trolly, and carrying two derricks, one on either side. The machine is drawn by a team of mules, and the two derrick beams are lowered, parallel to the direction of travel, so that the fixed forks are thrust forward along the ground, and pass beneath the scattered canes which thus accumulate upon it. When a sufficient load collects, the curved upper forks are brought down, and the load securely gripped. The beams are then raised by winding gear, and the loads released over the transport waggons, two of which travel alongside the loader.

In a trial made in 1902, when eight men and four boys operated the machine, it loaded 224 tons of cane at a cost of five cents per ton. A comparative trial by hand cost 15 cents per ton. In another trial, 51½ tons of cane were loaded into 35 waggons in 2 hours 7 minutes, with an average of 3½ minutes per waggon. The cost of this loader is about £54, and it is manufactured by the Electric Wheel Co., Quincy, Illinois.

In his 1904 model the inventor appears to have abandoned the automatic collection of the cane and has considerably improved the 1902 pattern.

4. *McNally*.—A steam propelled vehicle with an endless belt-conveyor mounted in front and at right angles to the direction of travel. The lower extremity of the carrier rests upon the ground whilst the upper end delivers the elevated cane upon an adjustable band which discharges direct into the loading cars. The inclined conveyor and band are driven by separate engines, the latter being also separately geared to the two large traction wheels by means of clutches, thus enabling the entire machine to swing round on either wheel as a pivot. Around the base of the inclined conveyor a feeding rake operates, but details of this arrangement are not at present published.

(c) *Unloading Arrangements.*

On the smaller estates in the West Indies the canes are dumped from the carts in the mill yard, and thence lifted by hand and thrown upon the carrier supplying the mill. On most of the larger estates where rail transport is adopted, the trucks are brought alongside the mill carrier, and directly emptied into it by hand, the depth of feed entering the mill being regulated by a driver who superintends the work.

At the Usine Ste. Madeleine, Trinidad, mechanical discharging rakes have been adopted for several years, dispensing with a gang of some thirty coolies formerly required for each spell of twelve hours.

1. *The Bodley-Mallon* apparatus consists of an endless chain carrying steel teeth or angle-pieces, mounted vertically on a frame hinged at its base, the width of the frame corresponding to the length of the transport trucks. The latter have hinged sides which are lowered before the truck passes underneath the raised rakes, which are then lowered upon the upper surface of the load, and the dragging action of the travelling chain pulls the canes into the conveyor leading to the mill. At the lowest position of the frame, the chain and teeth move horizontally just above the bottom of the truck so that the latter is generally completely emptied in a very few minutes.

The motion of the frame and gearing is operated by one man who can moderate the feed passing to the mill to a nicety. This particular installation has been operated most successfully for several years, four rakes discharging over 100,000 tons of cane per year.

2. *The Walsh* unloader is simpler but less automatic in action than the preceding. In place of the chain and teeth which form a continuous rake in the Bodley-Mallon design, a reciprocating motion is given to a beam carrying a single row of curved prongs, resembling the action of a common hand-rake. This is effected by causing the rake to slide upon one end of a lever-arm, the other extremity of the latter being hinged to an upright opposite the loaded truck. The rake is attached, by two lines, to separate winding-drums, which are driven alternately by a small engine. The motion of one drum causes the rake to descend upon the load and then to slide upon the lever-arm, thus dragging a part of the load on to the conveyor leading to the mill. The other drum hauls on a line, passing through an overhead block, which elevates the lever-arm and returns the rake to its former position. These two motions follow each other by the alternate movements of the levers by the attendant.

Similar appliances have been adopted in British Guiana for unloading punts. In this case, the canes have to be hoisted from the punt and dumped upon a platform, from which they are mechanically raked into the conveyor supplying the mill.

(To be continued.)

The amount of Java sugar imported into this country is steadily on the increase, and with a continued improvement in prices, it should replace a good deal of continental beet in our market.

The Spanish Sugar Trust, the "Sociedad General Azucarera de Espana," has established Central Offices at "Calle de Montalban 6, Madrid." It has now under its control 43 beet sugar manufactories, 13 cane sugar factories, and 13 sugar mills. But of these, 14 beet and 3 cane factories are to be closed in order to reduce expenditure.

AMERICAN *versus* BRITISH SUGAR MACHINERY.

The following letter recently appeared in the *Louisiana Planter*:—

EDITOR, "LOUISIANA PLANTER,"

I have received two numbers of the *Louisiana Planter*, to which I recently subscribed, and have read same, and I would like to say a few words in answer to an article I find in No. 12, page 193-4, headed "American *versus* British Sugar Machinery," in which the superiority of American machinery is claimed. I have had fifty years' experience in the manufacture, erection, and working of sugar machinery, and since the fiscal changes introduced here about four years ago, I have had considerable acquaintance with American machinery.

The article referred to, and others I have seen in American magazines, state that American machinery is superior on account of being lighter, better and higher finished. As to the American machinery being lighter, I quite agree; this can be seen plainly in the scrap heaps on all places that have lately introduced it here; as to its being better and higher finished, that is a great mistake; on the contrary, the finishing, both as regards quantity and quality, has to be done by the purchaser during the erection. A large factory here, put up lately with American capital, American talent, American manufactured machinery, American mechanics and American directing engineers, took off its first crop last year with great difficulty, doing only about half the work it ought to do, considering that it cost about two million dollars. The less than half crop made last year added about eighty tons to the scrap heap, and money sufficient to build a fair sized factory has been spent on it to get it ready for the present crop, but the breakage still continues, though not to such an extent as formerly. Another factory, two crops older than the one just mentioned, entirely under American control from the designing of the machinery to the bagging of the sugar, is just getting its head above a sea of breakdowns and difficulties, but will still have to spend a fortune to get the place into safe and economical working order. The capital lost through defective designing and building of the machinery amounts to many hundreds of thousands of dollars, and could never have occurred with British made machinery.

I have just been around a portion of the Island in the company of a young gentleman from Louisiana interested in some kinds of sugar machinery, and we have visited a number of factories, some having all American machinery, and others having British and American. The owners and engineers on these plantations have without exception complained bitterly of the quality of the machinery obtained from the States, and also about the bad finish and incompleteness of the delivery, so that my Louisiana friend has had rather an unpleasant time of it. It is now about the end of the crushing season here, and one of the factories we visited has only got through about one-fourth of its crop on account of the imperfections of the new machinery they have had from the States. This being a private concern, not a company like the first factories referred to, the losses mean something like ruin for the owners. On the other hand, there are dozens of plants of British manufacture in the Island that have worked without a hitch from the start and kept on working, giving excellent results for years; some for over forty years are doing better

work than most of the new American mills of similar capacity put up during the last four years. British machinery wears out with years of hard work, but rarely breaks.

The foregoing is absolutely true, simple facts, but you must not suppose that I am complaining. I own a foundry and machine shop here, and, since the advent of American sugar machinery here I have been just as busy as I can wish, and the outlook for the future looks good. Neither must you suppose that I think that good sugar machinery cannot be obtained in the States. I know that good, strong, well-finished can be obtained in the States, but there is only one firm in the United States that will make a complete, thoroughly up-to-date crushing plant without careful looking after. A good mill, crushing Louisiana canes of nine months, more or less, growth, would do poor work on Porto Rico canes of fifteen months, or smash up doing the work required here.

ROBERT GRAHAM.

Ponce, Porto Rico.

In a subsequent issue of the *Planter* appears an editorial in which the writer can scarcely conceal his indignation at "so severe and apparently so uncalled for" comments as revealed in Mr. Graham's letter. In fact he declines to believe them, and warmly invites refutations from other reliable parties. But we shall be rather surprised if these are forthcoming. Mr. R. Graham's name is well known to our readers, and his long residence in Porto Rico ought to be a guarantee of the accuracy of his allegations.

SUGAR CANE *v.* BEET.

The following letter regarding the respective merits of cane and beet sugar appeared in the *British Medical Journal* of the 19th April:—

Sir,—I have long been satisfied that with consumptives and children the nutrient fattening-power of ordinary grocer's sugar is *nil*. On numberless occasions I have noticed improved results when real cane sugar—preferably I think in the uncrystallised state—was used instead; chemically they are said to be "identical" just as potato spirits and malt whisky; practically they are as different. A recent inquiry in the *British Medical Journal* has evolved the following interesting communication from an expert, which speaks strongly in support of my experience: "I have had a long experience of cane and beet sugars. I have no interest in upholding the former, but the result of my experience has convinced me of the superiority of cane sugar over beet."

Chemically so far as our scientific knowledge goes—and it is not very far yet—both sugars when pure (and in the case of beet, this is a rarity) are alike. Chemistry in this branch is wanting; there is a difference chemically in my opinion which will be discovered soon; physically there is a big difference.

Cane sugar is easily purified, and even if it were not, the impurities unarrested would not have a prejudicial effect on the human system. Beet

is very difficult to clear, and in this case the impurities are such as to disturb the system and interfere with its normal functions. Low beet sugars or treacle cannot be used with satisfactory results even as a cattle food. Bees refuse to feed upon even the good grades of grocery beet sugars, they turn it out of their hives. There are cases where serious injury has been done to hives. I know of a case in the north where the bees, having nothing else, partook of some, and suffered from severe diarrhœa in consequence, many dying of it. Persons wishing to have cane sugar should buy from their grocers under guarantee. The country just now is flooded with foreign refined sugars, got up to please the eye, but only imperfectly refined.

I am, etc.,

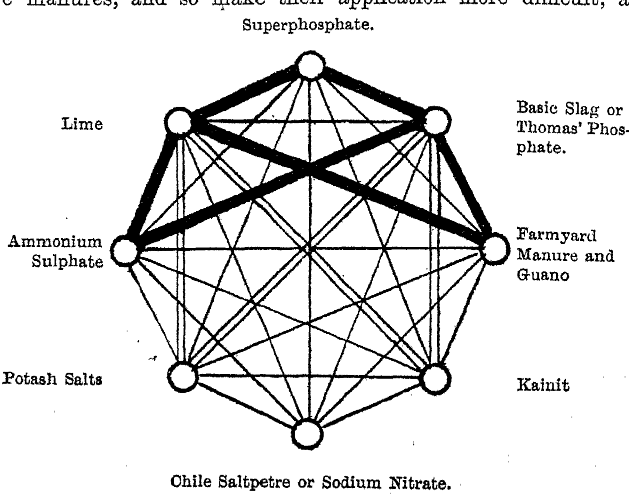
COLIN CAMPBELL.

MANURES, AND HOW TO MIX THEM.

Dr. Geehens, of Alzey, Germany, has furnished a very simple plan of determining what artificial manures may be mixed, and *vice versâ*. From the *Australian Agriculturist* we take the following notes and accompanying diagram :—

"In mixing manures before applying same on the land, chemical changes can take place, so that a valuable ingredient may be lost by a part of it flying off as gas, as example, the mixing of lime manures with such that contain nitrogen, as stable manure, guano, or ammonium sulphate, when the most valuable ingredient, the nitrogen, is lost in the form of ammonia; or an easily soluble manure changes into one difficultly soluble, and so loses in value, as example, the influence of lime on easily soluble phosphates.

"Secondly, mechanical changes can be caused by mixing two or more manures, and so make their application more difficult, and



consequently more costly. Mixing kainit or other potash salts with other artificial manures, if not spread immediately, will give a mixture that soon becomes a hard, solid mass, which must be broken up before application.

"To remember what manures can be mixed for any length of time, shortly, or not at all, before spreading the same on the land, cannot be expected of anyone who is not well up in the chemistry of manures. The accompanying diagram, which can be relied upon, is valuable for reference. For this purpose it can be tacked on the barn door, and everyone can see at a glance what manures can be mixed, and how long before spreading same on the land.

"Those manures joined by the thick lines must never be mixed before using; those by the double line, immediately before spreading; and those by the single line can be mixed together at any time."

THE SUGAR INDUSTRY IN JAVA.

By H. C. Prinsen Geerligs,

Pekalongan, Java.

The cane sugar industry in Java occupies a very peculiar position, differing considerably from that in other cane growing countries. Whereas in most other colonies the planters are proprietors of the land, and in other cases the manufacturers do not plant their canes themselves but only make sugar from purchased canes, the Java manufacturer plants his cane himself on rented land. Apart from the estates in the semi-independent states of Sourakarta and Djokdjakarta and a few estates situated in private possessions or perpetually leased farms, the cane is planted in Java on land which is rented from the native population for one crop at the time only. Therefore the denomination of "plantation" is not applicable to the Java sugar estates, as only the factory compound is the property of the estate, and the land planted with cane belongs to the natives in communal possession.

This state of affairs brings along a general feeling of uncertainty; the planters are never sure of the disposition of the land and even if they have done their utmost to bring the factory and the transport arrangements to a high state of efficiency, all this trouble may prove useless if the natives are unwilling to lease their land furthermore, or if another planter forestalls them. This latter inconvenience may be obviated by mutual agreements between neighbours, preventing one estate from renting land within the area allotted to another, but it is obvious that such an agreement is only based on mutual confidence and goodwill, and that in case one of the parties wants to cancel it or an outsider steps in, it may become very difficult to obtain sufficient land for the capacity of the factory.

In the semi-independent States, where the character of the rent is more that of a perpetual lease, the conditions are more favourable; one is sure of the land and therefore can afford to lay out more on permanent improvements and roads or railroads, than when one cannot say whether the land owners will lease it or not another year.

Another point of difference between Java and most other colonies is that in Java cane is planted exclusively on irrigated land. The same land, which is used for rice cultivation and, therefore, is provided with irrigation canals, is planted with cane after the rice crop is harvested and thus the cane profits also from the irrigation works.

The cane is planted in the dry monsoon and therefore requires irrigation water to enable it to sprout and to develop until the rainy season sets in and furnishes the necessary moisture. The use of the irrigation canals is adherent to the land, so nothing is paid for them, they only need to be looked after in the interests of the planter. Within the last few years the area under cane has undergone a great extension, even to such a degree that the amount of irrigated land has proved insufficient; large pumps have therefore been constructed with a view to pumping water from the rivers, and thus make great tracts of land fit for the sugar cultivation.

The labour question, which is the most important one in most tropical countries, is not very pressing in Java. The usually rather dense population, living in the vicinity of the sugar cane estates, works by the day, thus saving us the trouble of importing coolies with their accompaniments of labour contracts, hospitals, &c.

As a matter of fact we have in Java a minimum of very expensive land and abundant and cheap labour, whilst in most other cane growing colonies the planters dispose of a great deal of cheap land in their possession, but suffer from scarcity of labour. Whereas in those countries the cultivation is carried out on an extensive scale, we are compelled by circumstances to cultivate the small portion of land allotted to us intensively and to try to make the most of it. This explains the heavy returns of cane and sugar per acre reported from Java, as compared with those obtained in other countries, and also why in these latter countries the planters do not imitate the Java methods of working. It is not because Java is so highly favoured by nature, but chiefly in consequence of the so much more costly intensive cultivation, which is not possible in colonies where labour is scarce and moreover is not required if the land is cheap and abundant. Nature does not favour Java over much; the soil is poor and if the hot and damp climate did not promote the decomposition of the rocks and the assimilation of their constituents, agriculture would not thrive.

Furthermore, the great drought which prevails during six months of the year is a great hindrance and hampers the development of the cane, while to make matters worse during that period of the year the amount of irrigation water is limited and even sometimes totally fails.

Finally the mysterious *sereh* disease, which has infested our cane fields for the last twenty years, forces us to spend large sums of money in purchasing sound planting material, at the same time preventing us from keeping ratoons which in other countries are sure to yield the largest profit.

It is thus a fact that Java does not really possess the most favourable conditions, the only factor in our benefit being cheap and abundant labour, which enables our planters to cultivate their land intensively and to neutralise by heavy returns the different disadvantageous factors. On the other hand, it is equally obvious that other countries, not possessing our advantage of cheap labour, cannot adopt our methods without alteration. The large returns per acre made in Java are only the result of inherent circumstances, and the great pains we have taken to obtain them are also a consequence of the necessity for maintaining our industry.

The days have passed when one could live quietly in Java and yet make money; now we are forced to do everything we can to save expense and, by constantly increasing the weight of cane reaped and of sugar extracted therefrom in the factory, bring down the cost price of the product in order to secure a profit, in view of the ever falling price of sugar on the world's market.

We shall consider here how this is done.

Suppose the estate has secured the disposal of the necessary land by contract with the native land owners, then the sugar cultivation starts immediately after the rice crop. Usually two rice crops fall between two sugar crops, while between the intervals beans, maize or indigo are planted on the same land; as a rule we come back to the same land once every three years after the second rice crop, as will be shown by the table underneath :—

Year.		
1.	September—November	beans, maize, &c.
1–2.	November—April	rice.
2.	April—November	fallow, beans, maize, &c.
2–3.	November—April	rice.
4.	April—September (of next year)	sugar cane.

As soon as the rice is reaped, and sometimes even during that operation, a deep ditch is dug round the field in order to drain off superfluous water. Owing to the wet rice cultivation, the soil has been saturated with water during the last months, all kinds of reduction processes have taken place and oxygen fails totally. In order therefore to render the land fit for cane the soil must be exposed to the action of sun and wind. To this end the field is divided by transverse ditches into portions of one-fourth or one-fifth of an acre and between those ditches the rows in which the cane is to be planted afterwards are dug. Ordinarily these are thirty feet long, one foot wide, a little over one foot deep, and four or five feet apart. The

excavated soil is heaped up between the rows. In some places, where the nature of the soil so allows, the land is ploughed first and afterwards the rows are dug with the native spade. When the field is thus prepared it has the aspect of a large network of trenches, which remain exposed to the sun's rays for about six weeks. It is still unknown what chemical reaction takes place during this drying of the soil but experience has taught us that that period of lying fallow is indispensable to obtaining a good crop. The wet lumps of soil dry up during this operation, crumble to pieces, and assume a lighter colour, causing the mass of moist, cold, hard lumps to change into a loose, greyish, powdery soil. During this weathering all grass is carefully weeded out, and this is continued too after planting until the cane has grown so high that it keeps down the weeds by its own shadow. At the end of the drying time the soil in the rows is loosened a little, and then the cane tops are planted in them. The supply of good, sound cane tops for planting is one of the many sources of trouble to the manager; in former times, before the *sereh* disease attacked our cane, the tops of the crushed canes were exclusively used for planting new fields, as is the custom in every other part of the world, but as soon as it was observed that such fields were badly infested by the disease, the tops for the new fields were specially planted in remote spots, and now every year a greater or smaller part of the estate is planted with fresh tops from the special cane top fields. The expenses involved hereby are enormous, first of all, owing to the price of the cane itself, amounting to £1 10s. per ton and next to the high railway charges. Say we want 2½ tons of tops per bouw or 1½ tons per acre, then the price of the tops alone is £2 5s. and the railway transport of a eight-ton car, put down at £8, adds to that amount £1 10s., so the supply of tops for a field planted with fresh tops costs no less than £3 15s. per acre. As every year a part of the estate is planted with this expensive material we may calculate the cost of tops at about 7s. per ton of sugar.

It would be a great boon if something could be done to rid us of these heavy expenses: as it is, many attempts have been already made, but without real success.

First of all, importation of new varieties from other countries has been in great favour in the hope of finding a species of cane that could stand the disease. It was especially our best and richest variety, the Cheribon or Black Java cane, that suffered most; other varieties suffered less but as these were rather poor and did not pay, their immunity was of little use and efforts were consequently made to import canes in the hope of hitting upon one that would combine the excellent qualities of the Cheribon cane with an immunity against *sereh*. Of the canes thus imported, we may mention the varieties Louziers from Mauritius, Muntok from Bangka, the white and the black Manilla canes from the Philippines, canes from Batjan and Borneo,

&c.; but of all these varieties not one has been able to take the place of the Cheribon cane. This variety grows as well on a loose as on a stiff soil, can stand drought and rainy weather equally well, is a vigorous grower and possesses a rich and pure juice, which is easily worked up into sugar, and finally can stand a long time in the field without deterioration even after it has reached its point of maturity. The other varieties mentioned do not combine those good qualities; Louziers and Manilla cane do not like a heavy soil, Muntok cannot stand drought, Borneo is not totally immune against sereh, &c., so these varieties have a very restricted area and are not so universally planted as the Cheribon cane, for which they are but poor substitutes.

Besides the importation of the foreign canes, some scientists have advised one to pick out the sound tops from affected fields, thus selecting the healthy individuals, grown up under the influence of infection and yet having escaped it, and offering the possibility of being individually immune, with a chance of communicating that property to their descendants and so giving rise to an immune race. However, it soon became apparent that the number of sound canes was decreasing every year, and it ended in their total disappearance.

After the discovery of the seedling canes expectations were very sanguine, the more so as the general feeling ascribed the *sereh* disease to degeneration of the cane caused by constant sexual propagation. If this was a fact, then of course an entirely new race, raised by fertilisation, must needs be immune against the disease. This, however, soon proved incorrect, since several varieties of seedling canes were as liable to be attacked by *sereh* as the older Cheribon cane itself. The scientific cross fertilisations however, made by both planters and scientists, have given rise to a great number of new cane varieties, combining a large yield and a satisfactory saccharine content with a certain immunity against disease. The first results were astonishing, and a general idea got about among the planters, that they had only to buy a few car loads of seedling cane tops of a variety which gave satisfaction in one place or other to be rid of every trouble with the supply of cane tops for the rest of their days, but it soon became evident that those new varieties were much more sensible to slight changes in the climatological or meteorological conditions and to changes in the nature of the soil than the already acclimatised and older cane varieties. The same seedling canes that yielded incredible crops during one year or in one place were often an utter failure the next year on the same land, or even in the same year but in another place. The enthusiasm for seedling canes, which was exaggerated at the outset, was gradually reduced to more reasonable proportions, and now everyone agrees that it will not do to buy some tops which gave satisfaction elsewhere, but that it is necessary for every estate to raise

that variety of cane that is best adapted to the prevailing conditions of soil and climate.

As long as this desideratum is not attained, we are compelled to go on importing the fresh tops from the special cane top fields in the hills. A great drawback of these tops, apart from the heavy expense already referred to, is their liability to attacks of infectious diseases, because of their being softer and more watery than tops of the full-grown canes. The large surfaces laid open by the cutting of the tops offer, during the lengthy transport, a favourable breeding place for fungi of all kinds, especially for the black rot fungus, which easily penetrates into the soft juicy top, killing or damaging the eye, so that the top either does not sprout at all or else the young plant dies off in its early youth. The penetration of fungi is hindered by tarring the ends of the top or by soaking it in Bordeaux mixture. Yet this remedy sometimes fails through careless application, especially when hundreds of tons have to be treated at the time. Further, the mysterious yellow stripe disease has made its appearance with the introduction of tops from the hillfields. This disease, the cause of which is unknown as is the remedy for it, causes yellow stripes on the leaves; in the affected spots the chlorophyl has disappeared, therefore the assimilation of carbonic acid in those spots is hindered and the plant suffers. Manuring with sulphate of ammonia makes the stripes less visible because of the deeper green coloration it imparts to the still sound portions of the leaf, but it does not thereby remove the cause of the malady. The disease is hereditary and seems infectious; in appearance and action it has much in common with the well-known mosaic disease of the tobacco plant. It is believed that seedling cane is immune from the yellow stripe diseases, but these canes have still been so short a time under observation that nothing can be said with certainty on this last point.

But even taking into consideration the enormous expenses occasioned through the cane top supply, it is still very probable that if we could find varieties capable of resisting every disease, we should go on planting tops in special fields. Even planters who have their whole estate under seedling canes, continue planting special land for raising tops only, and this for the following reason. When only tops of the crushed cane are disposable for planting one cannot plant a new field unless an old one is cut. When the new field is ready for receiving the tops at a time when the old cane is not ripe, we have to choose between losing time in planting the new field or losing money by cutting the still immature cane. Again in many cases it is necessary to allow cane to remain a long time on the field before it has reached its maximum saccharine content, but then the top has dried up and is unfit for propagation. In all these cases we are constantly at a loss what to do; either crush the unripe canes to secure sound tops or to allow the cane to ripen and have an inferior

planting material. Ordinarily the end is a compromise between the two alternatives. Therefore it is much better to spend a little more money for the top fields and thus separate the interests of the two crops than cut the canes unripe for the sake of the tops.

The tops are deprived of their leaves, cut in pieces bearing two or three eyes, and disinfected once more. Experience shows that the uppermost eyes sprout earlier than the lower implanted ones. Thus in order to ensure a more regular cane field the tops are picked before planting, in such a way, that all the topmost pieces are planted in one division of the field, the second pieces from the top in another, and so on. By this separation we prevent some plants from sprouting earlier than others and thus overshadowing them, because all plants of the same division sprout and grow at the same time. Together with these we plant at the end of every row a few extra tops as a reserve; when some plant in the row dies or looks unhealthy its place is supplied by another plant of exactly the same age.

The tops are laid down in the loosened soil at the bottom of the rows, slightly covered with earth, and well watered. Every four or five days the young cane is irrigated and the field is constantly examined so as to detect diseased or dead plants, which are immediately replaced by healthy ones.

Either at the same time as planting takes place, or after it, the fertilisers are distributed over the field. We are accustomed to spend much money on manuring in Java, £2 10s. per acre on an average, so it is important that this heavy item be well applied and that the fertilisers be given in the most rational form and during the most favourable periods, especially in a tropical land where heavy rains might drain the fields and carry off the costly manure to the sea. The sugar cane manure exclusively used in Java is a nitrogenous fertiliser; potash and phosphoric acid, which are missed in no fertilising mixture, find no application here, as numerous experiments made at the experiment stations in Java have shown they do not improve the quantity or the quality of the cane manured with them. It must be observed that I am now speaking of Java only and of cane planted on land which bears two rice crops on irrigated land between two cane crops. The irrigation water, which inundates the rice fields, carries along a great amount of fertile river silt, depositing it on the land and so creating every year a new and fresh layer of highly fertile soil, the constituents of which become assimilable by the drying process previous to planting.

The fertilisers consist of oil cakes of pea-nuts, soy beans, castor oil seeds, and next of sulphate of ammonia. The nitrogen in the sulphate is cheaper than that in the organic nitrogenous fertilisers and yet most planters prefer the latter to start with. The nitrogen becomes gradually available and so is a constant and slow source of nutrition to the cane. Sulphate of ammonia, however, gives up its

nitrogen all at once and therefore is more a stimulant than a nutrient. As soon as the cane has reached the age of six or eight weeks and is well developed, it is advisable to give it sulphate of ammonia, which causes the sap to rise in the plant. The already existing leaves are insufficient to work up all this sap and now the undermost buds sprout, promoting the development of secondary stems, and so increase the yield of cane. This is only then useful if one is certain of obtaining the necessary irrigation water to keep these secondary stems alive, for if they have to suffer from a long spell of drought they are sure to die, and all expense and trouble is lost. Pen manure is not used; the Javanese do not collect their dung, and even if the estates were willing to pay for it they would mix it up with sand or rubbish in such a way that it would become worthless. When the young cane grows it becomes infested with numerous animal pests, of which we might mention termites, boring caterpillars, beetles and their grubs, and mice; besides those, there are still many more but the harm done by them is not quantitatively so important. The termites are troublesome on dry land only, the beetles tunnel the canes in some districts, while the grubs of other beetles feed on the roots of the cane and occasion much damage. They are especially numerous in the eastern part of the island, where much trouble is taken to exterminate them. The adult beetles settle down to feed on the leaves of some shrubs at night time, of which peculiarity we profit by spreading sheets under those shrubs and shaking the branches, thus causing the beetles to fall down into the sheets and get caught. Mice are only noxious in dry years, when the food supply in the rice fields is insufficient, then they come into the cane fields to devour both the old and the newly planted cane. All experiments to get rid of the mice by killing them with mice typhus baccilli have failed, either because the mice are not of a kind that is liable to the disease, or for some other reason. We poison them or knock them down with clubs but real extermination is impossible; fortunately the mice leave the cane fields as soon as the rice is planted again. Locusts, which are so common in tropical countries, are found in Java in many varieties but are relatively harmless; perhaps the lack of a desert, where they can develop themselves undisturbed and from whence attack the plantations in large numbers accounts for this innocuousness. By far the worst enemies are the caterpillars and among these especially the boring ones. Up to now we have detected five kinds, which attack the cane each in its peculiar way. Some of them lay their eggs on the leaves in clusters, some in rows, and others separately.

The young caterpillars bore holes in the leaves and move slowly eating their way towards the stem, thus killing the upper part of the cane, here they pass their pupal stage, issue as butterflies to copulate and to lay eggs again, and thus give rise to a new generation of

enemies. From their hidden position in the interior of the cane they escape the attacks of birds, ants, wasps, &c., and are difficult to catch. The damage done by them is not only due to their boring holes, for by doing so, they open the door to infection with fungi, as red smut, black rot, and other moulds of a similar nature. The destruction of the borers is conducted on a very intensive scale, as well by collecting the clusters of eggs as by cutting off canes, which from their appearance betray the presence of a borer in their interior. Most planters pay a premium for a number of borer caterpillars and their eggs, but they require to be very careful as to their identity before paying, since the Javanese do not hesitate to bring in spurious or artificial borers' eggs, which they want to be paid for as genuine.

The cane, escaping from all those pests and diseases, grows longer and requires a second banking. For this purpose the lower end of the cane is deprived of trash, and loose earth is heaped up against it, causing the cane that was first planted in a furrow to stand ultimately on a bank. This work must be finished before the period of the heavy rains sets in, in order to allow the rainwater to flow off directly, as nothing is so pernicious for sugar cane as stagnant water.

(To be continued.)

MANURIAL EXPERIMENTS IN THE LEEWARD ISLANDS.

The report of the manurial experiments carried out in connection with the sugar cane experiments in the Leeward Islands under the supervision of Mr. Francis Watts, F.I.C., F.C.S., for the season 1902-03, has just been issued. While of the usual voluminous character associated with these annual reports, it includes a useful summary, parts of which we are enabled to reproduce below. The chief point deduced is evidently the fact that, under the conditions existing in those Islands, (where in the preparation of the land pen manure is used, and where the rainfall is from 45 to 55 inches,) artificial manures are not necessary nor advisable for plant canes, although for ratoons their application is decidedly remunerative.

For the practical planter, the result appears to be established that he will do well to concentrate his attention upon the preparation of his land, and its manuring with about 20 tons of good pen manure per acre, after which, for plant canes, artificial manures are not required, and will not prove remunerative.

Plant canes, properly planted, have a sufficient supply of plant food for economic purposes. Additional nitrogen slightly increases

the yield, but not to a remunerative extent. Potash also increases the returns slightly, but is doubtfully remunerative. The results of the application of phosphate to plant canes have been unexpected. The soils of the Leeward Islands are usually deficient in phosphates, and it was expected that the use of phosphatic manures would materially increase the crop. This has not been the case; as a matter of fact, the largest returns have been obtained from the plots receiving potash and nitrogen without phosphate. This was so unexpected that an additional series of experiments was laid out in St. Kitt's with a view to testing these results: in this series each of these experiments was repeated ten times. As will be seen from the context, the same result is arrived at when the mean of all these experiments is considered. The plots receiving potash and nitrogen gave larger returns than the plots receiving phosphate in addition.

Under different conditions, for example, where there is a heavy rainfall, or where a thin layer of soil rests upon a porous substratum, as is the case in Barbados, or where irrigation is practised, as in Hawaii, very different results may be expected, and, under these circumstances, artificial manures may be both remunerative and necessary for the growth of plant canes: we are, however, here only concerned with the requirements of the sugar planters of the Leeward Islands.

With ratoon canes the case is quite different. Here we find that most of the combinations of artificial manures used give substantial monetary gains.

In studying the results of the phosphate series we see that the addition of 40 lbs. and of 60 lbs. of phosphoric acid as basic phosphate to a manuring of potash and nitrogen slightly increases the yield of sucrose by 280 lbs. and 500 lbs. respectively, while there is an increased monetary gain of 92c. from the use of 40 lb., and of $2·18 from the use of 60 lbs. The use of 80 lbs. has resulted in a diminished yield.

The use of superphosphate has given somewhat similar results. The return from 40 lbs. of phosphoric acid as superphosphate has not been so good as from an equivalent amount of basic phosphate; while 60 lbs. in either form have given almost identical results; but superphosphate being slightly dearer, the monetary return is not quite so good.

A small quantity of phosphate, which may equally well be basic phosphate, increases the yield of sucrose.

In the potash series the plots receiving nitrogen and phosphate without potash have given almost as good results as the plots which have had potash: 60 lbs. of potash (equal to 120 lbs. of sulphate) gave the largest return in this series, but the increased cost of the manure

was greater than the increased value of the crop, from which it would appear that potash was not required.

In the nitrogen series we obtain unequivocal evidence of the value of nitrogen for ratoon canes. In practice good monetary returns are obtained from the use of nitrogen without potash and phosphate. Nitrate of soda has given slightly better monetary returns than sulphate of ammonia.

When used with potash and phosphate, 40 lbs. of nitrogen, as nitrate of soda, (about 250 lbs. of nitrate), in one application, have given the best monetary returns, namely, a gain of \$10·94 per acre; while 60 lbs. of nitrogen, as nitrate of soda, (about 380 lbs. of nitrate), in one application, have given a monetary gain of \$10·45. In every case it is found better to give the nitrogen in one application than to divide it into two.

For practical purposes we may therefore briefly sum up thus:—

Plant canes, when the field in which they have been planted has been properly tilled and manured with pen manure, require no artificial manure. When the soil is in good condition, but it has been found impossibe to give the proper dressing of pen manure, then artificial manures may prove remunerative: under these circumstances it is suggested that either $1\frac{1}{2}$ to 2 cwt. of sulphate of ammonia, or 2 to $2\frac{3}{4}$ cwt. of nitrate of soda be given in one application. A small additional profit will probably follow from the use of $\frac{3}{4}$ to 1 cwt. of sulphate of potash together with phosphate, either $1\frac{1}{2}$ to 2 cwt. of basic phosphate, or a similar amount of superphosphate. All of these manures should be given early.

For ratoon canes nitrogen is very necessary, and this may take the form of 2 to 3 cwt. of nitrate of soda, or $1\frac{1}{2}$ to $2\frac{1}{2}$ cwt. of sulphate of ammonia. Remunerative results will be obtained without the use of potash or phosphate, but a small additional profit may be expected from their use: $\frac{3}{4}$ cwt. of sulphate of potash, and $1\frac{1}{2}$ to 2 cwt. of either basic phosphate or superphosphate may be employed. It is quite clear, however, that nitrogen, in a rapidly acting form, *must* be used if good ratoon crops are to be grown.

The most striking feature is the detrimental effect of dividing the nitrogen into two doses: this is observable to some extent in the plant cane series.

The effect is more marked where potash and phosphate accompany the first dose of nitrogen. But the effect becomes most marked where no phosphate is present and potash in considerable quantity is given with the first dose of nitrogen. We suggest that this has some important physiological significance, indicating that when considerable quantities of available potash are present, an equivalent quantity of available nitrogen must be present at the same time, if

full, vigorous growth is to be obtained, and that this full, vigorous growth cannot be secured by the addition of an equivalent quantity of nitrogen later.

These results lead us to make the suggestion that manures applied to sugar canes will probably be found to be more efficient, both physiologically and pecuniarily, if given in quick-acting forms at a very early stage of the canes' growth, and we are led to speculate whether this may not be accounted for, on botanical grounds, by the structure and manner of growth of the cane. We have perhaps been too prone, when thinking of manuring crops, to have in our minds dicotyledonous, branching trees, with many growing points, instead of the sugar cane with its one growing point or "top" to each stem. The cane, having largely lost its habit of seeding, may be regarded as consisting of a growing top and a stem. When the former has arrived at its full development it may be taken roughly to be a fixed quantity; old leaves fall away and are replaced by new ones, so that the top remains fairly constant. The stem constantly receives addition, and gradually ripens to form a dormant store-house chiefly filled with sugar, doubtless originally destined to provide for the growth of flowers and the production of seed, but now developed to a greater extent than the feebly fertile flowers demand.

The elements of plant food, including nitrogen, potash, and phosphate, are found in greater abundance in the "top" and leaves than in the stem; hence it is reasonable to suppose that in the early development of the cane plant with its system of top and stem, greater demand is made upon the plant food supply to the soil in order to build up this top rich in plant food, than occurs later on when the top — a comparatively fixed quantity — has been developed and additions are being made to the stem, which additions demand relatively large amounts of carbohydrates with comparatively small amounts of nitrogen, potash and phosphate. Transference of food material from point to point takes place freely, and it is reasonable to suppose that the cells of the stem, as they pass into the dormant condition, may pass on some of their nitrogen, potash and phosphate to be used in building up newer structures. We are aware of this transfer of plant food in the case of the leaves, where the faded and falling cane leaves contain much less plant food than the actively growing ones.

In order to have fresh information on this point, analyses have been made of fresh cane leaves, and of dry cane leaves just as they were about to fall from the plant but not actually fallen.

The results are as follows, and show in a striking manner the nature of the transference of plant food material from the leaf back to the stem as it ripens and its lower portion becomes dormant:—

ANALYSIS OF ASH.

	Green Leaves.		Trash Leaves.
Silica..	46·26	....	63·31
Carbon ..	3·52	....	3·47
Iron oxide	·49	....	·38
Alumina	—	....	·03
Lime..	4·68	....	6·67
Magnesia	5·08	....	5·10
Potash	17·23	....	6·49
Soda	6·60	....	3·58
Phosphoric anhydride	1·39	....	·93
Sulphuric anhydride	5·45	....	5·18
Carbon dioxide	2·39	....	1·97
Chlorine	9·09	....	1·83
Water	1·25	....	2·59
	103·43	....	101·53
Oxygen equivalent to chlorine (to be deducted)..	2·02	....	·40
	101·41	....	101·13
	Dried Leaves.		Dried Trash.
Nitrogen ..	·777	....	·36

GRAMMES OF MINERAL MATTER IN ONE LEAF.

One fresh cane leaf contains ·9688 grammes of ash.
One ,, trash ,, ,, ·5304 ,, ,,

	Green Leaf. Grms.		Trash. Grms.
Silica..	·4419	....	·3321
Carbon ..	·0336	....	·0182
Iron oxide	·0047	....	·0020
Alumina	—	....	·0002
Lime..	·0448	....	·0350
Magnesia	·0485	..	·0267
Potash	·1645	....	·0340
Soda	·0630	....	·0188
Phosphoric anhydride	·0134	....	·0048
Sulphuric anhydride	·0520	....	·0272
Carbon dioxide	·0228	....	·0103
Chlorine	·0868	....	·0096
Water	·0118	....	·0136
	·9878	....	·5325
Oxygen equivalent to chlorine (to be deducted)	·0193	....	·0021
	·9685	....	·5304
Nitrogen ..	·094	....	·032

If this manner of regarding the cane as a growing organism is correct, it may lead us to modify some of our ideas concerning the manuring of sugar canes, and may account for the better result obtained by applying considerable quantities of nitrogen in one dose at an early stage, and from the smaller results obtained from the use of such a slow-acting manure as dried blood.

SUGAR INDUSTRY OF THE ZAMBESI.

The following particulars concerning the sugar industry of the Zambesi are extracted from a report recently received at the Foreign Office from H.M. Consul at Beira:—

The sugar industry of the Zambesi has, to all appearance, a prosperous future before it. Commenced nearly 14 years ago in circumstances of great difficulty, it has succeeded in overcoming many of the obstacles which it was first called upon to face. It has, moreover, proved that, if sufficient capital be provided at the outset, a good return may be looked for. The moist, hot climate appears to be favourable to the rapid development of the cane, whilst the rich, clayey soil is said to be capable of producing results comparable to other countries celebrated for their successful participation in sugar cultivation. Added to this, the proximity of the great river, together with the facility with which the various systems of irrigation may be applied from it, render the cultivation of sugar, if not wholly independent of the somewhat uncertain rainfall, at least in a much better position to guard against the disastrous effects of a lengthy drought.

Available Land.—The area of land available for this industry in the valley of the Zambesi is enormous, whilst the composition and character of the soil do not vary. The acquirement of large areas suitable for agricultural purposes would not, moreover, be attended, it is thought, by the difficulties which would be encountered in less remote regions. The north bank of the river, except where the country is in the hands of persons occupying the enormous districts called "prazos," is controlled by the Portuguese Government and administered by the Governor of the extensive district of Zambesia. On both banks, however, an almost endless chain of prazos is found. On the south side the greater part of the riparian proprietorship is vested in the Luabo and Gorongoza Companies, whilst the remaining districts of Cheringoma, Chupanga, and Kaia are directly or indirectly beneath the control of the Mozambique Company. The effect of this prazo proprietorship, now become so general, is that persons seeking land for any purpose, instead of going direct to the Government, as

would be the case in a British Colony or Dependency, obtain it, in the majority of cases, from the lessee of the prazo in which it is situated. It must, naturally, be held under a sub-lease, and, as will be readily seen this arrangement has the disadvantage that the applicant's tenure of his land so sub-leased must be more or less dependent upon that of his landlord, the prazo holder from whom it is derived. Possession can, however, be cheaply and expeditiously obtained, and the only conditions usually imposed are such as would be amply fulfilled in the process of sugar cultivation.

Of the two large companies now engaged in this pursuit, one is established on the north and one on the south side of the river. They are provided with expensive labour-saving machinery and appliances, and have, apparently, spared no pains to make the production of this valuable commodity one of the most important industries of the East Coast of Africa.

Drainage and Irrigation.—At the present time, the land under actual cultivation approximates to 5,000 acres, and is all, needless to say, close to the river. Large forests provide ample timber for building purposes, as well as wood for fuel, the district, moreover, being sufficiently thickly populated to remove all doubt as to the sufficiency and permanence of native labour.

The first preparation of the ground takes place in the dry season, between the months of April and November, during which time but little rain falls. Throughout this season a careful and well-organised system of irrigation is essential, in order to produce the best results.

Planting.—The planting of the cane commences with the advent of the rains (usually about December). At the conclusion of the rains, irrigation continues without intermission until the cane is cut in June or early in July. Thereafter, crushing is carried out unceasingly until the end of October, the juice being in its finest condition in August. A well-equipped factory is provided with mills capable of dealing with about 350 tons of cane in the full day of 24 hours. One acre of land is calculated to produce about 15 tons of cane, which in turn yield about 185 lbs. of sugar to the ton.

Markets, Freight, &c.—The sugar is sent for disposal to Portugal, freight, including transport to the coast, amounting to about 43s. per ton.

Lisbon takes the entire output, granting a bounty and a reduction of 50 per cent. of the import duty payable on sugar imported from other countries. In addition to this, further protection has been granted to the Zambesi planters by the increase of duty on foreign sugar entering the ports of the Province of Mozambique, this duty having been raised from £3 6s. 8d. to £13 6s. 8d. per ton, or four times the amount.

In his concluding remarks, H.M. Consul refers to the difficulties which sugar planters on the Zambesi are, at times, called upon to face in guarding against the ravages of beetles, locusts, and crickets, and also against the losses incurred by the devastations of game and hippopotami. He adds that in spite, however, of these disadvantages, which are now rapidly diminishing before the advancing facilities of river transport and improved communication, there can be no doubt that in the hands of trained men, employed by firms possessing sufficient capital to provide the best available machinery, carrying out irrigation works on scientific principles and exercising patience, the immense valley of the lower Zambesi should, in the future, attract large numbers of those interested in the cultivation of sugar.

THE INVESTIGATION OF THE PROPORTION OF TIN FOUND IN SUGAR.

By Dr. M. Pitsch.

Recently, four samples of sugar were sent to the *Vereins* laboratory to be tested for the presence of tin, having been bought at Georgetown, Demerara. The analysis, already reported in the *D.Z.I.*, was to the effect that all four samples were, indeed, free from organic colouring matters, yet without doubt were produced under application of *bloomer*, or tin chloride, since in the course of quantitative analysis the presence of tin was clearly established. But as this substance is not marked directly by any strong characteristic action, it seemed desirable by means of a suitably arranged test to establish beyond all doubt that the matter found by quantitative analysis by the customary methods, was really tin and not another analogous metal. It seemed, moreover, advisable to ascertain with certainty that the presence of tin in the Demerara sugar really arose from the employment of tin chloride, and was not produced from the apparatus and vessels in the course of manufacture.

In the last case it would have had to be taken for granted that similar amounts of tin were also found in European beet sugar, which was produced with essentially the same apparatus as the colonial sugar.

As is known, faint traces of metallic combinations have already been detected in sugar ash, one need only remember the American accusation against continental beet sugar that it contained an excessive amount of lead. The plant, unlike the animal, cannot protect itself from absorbing matter from the soil. We must, therefore, expect, as Lippmann has shown does actually occur, all natural soil constituents to appear again in the beet or cane sugar, even though in only minute quantities. Von Lippmann has

demonstrated that besides potash and soda, the rare alkalies, lithium and rubidium, and boric acid, the substance which has of late attained such ominous notoriety, reveal themselves in sugar as in all plant and animal productions.

Tin is manifestly so little distributed in nature that its entrance into sugar is a natural phenomena is highly improbable. One has, moreover, never heard that the Demerara soil contains sufficient tin as to account for the presence of that minerial in Demerara sugar.

At the suggestion of Professor Herzfeld, the writer undertook to investigate on the one hand the above-mentioned Demerara sugar, on the other, ordinary beet sugar, as regards their content in tin. As a consequence, it is positively shown that Demerara sugar is undoubtedly produced with the aid of tin combinations, *e.g.*, tin chloride, whereas the beet sugar is absolutely free from the presence of tin.

Since, with the above-mentioned sugar samples, it could only be a question of a relatively small amount of tin, the writer procured a fairly large amount, viz., 100-200 gr. sugar for each test.

Such an amount of sugar, while not lending itself to the adoption of the test for tin and arsenic in foods and drugs under the Government Order of April, 1888, when it is prepared for analysis by boiling with HCl. and chlorate of potash, nevertheless produced the qualified supposition that the tin existed in the sugar as tin chloride, a combination volatilizing at 120° C., which preceeds the decomposition of the sugar by heat, a soaking with soda solution and the transformation of the stannous chloride into stannic hydrate.

The burning of a substance containing tin should not as a rule be undertaken in a platinum vessel, but as we will show the employment of platinum in this case offered no risk, because the amount of tin in the sugar did not exceed one or two milligrams per 100 mgr. of sugar, and this tin after the carbonization of the organic substances was entirely surrounded by voluminous residum and so protected from combination with the platinum. Furthermore, the mistake which might result from casual combination with the platinum would result in an alteration to the amount of ascertainable tin; but this would be to the advantage of the judgment on the sugar. But the object of the experiments was merely to establish whether there was tin at all in the English colonial sugar.

100 to 200 gr. of sugar do not permit of burning in a porcelain saucer without the later easily bursting; the mass liquifies on heating and the melting mass comes into contact with the frame of the saucer that was already red hot, and cools it so rapidly that the vessel is unable to stand the rapid change of temperature.

A platinum saucer was therefore employed with a capacity of 400 cc. and the carbonization of 100 gr. sugar was possible in one operation. The saucer was heated over a triple burner working from rim to centre in spiral progression.

There finally remained the well-known black, very porous, lava-like cake, that still gave off some bluish burning gases, weighing only some 10-15% of the sugar introduced to begin with, which lay quite loose in the saucer and could be emptied direct out of it. Thereupon the heating was stopped. The complete incineration of the sugar purposely avoided and for the following reasons.

The tin present in the sugar as chloride is converted by the action of the soda into stannic hydrate. On heating the sugar it is reduced by the organic substances to metallic tin again.

So long as the issuing gases burn with a luminous flame, and the surplus carbon is present, no oxidation of the tin can well occur. The tin is also easily extracted from the unburnt residue with HCl.; but it is also securely surrounded by the carbon, so that it is not affected by the platinum.

But if one desired to complete the incineration—possibly in a porcelain crucible—then the tin would be burnt to tin oxide, that we know is insoluble after heating in acids.

It might therefore not be altogether impossible to recover with HCl. from the pure ash of a sugar containing tin, an extract which would yield a filtrate free from tin. The carbon was rubbed to a powder treated at least an hour to cold digestion with concentrated HCl., the pap then diluted with two parts of water and heated under frequent application of chlorate of potash. The liquid was then filtered off, the filter washed out with hot HCl. water, and the filtrate and wash water steamed on the waterbath.

After separation of the silicate, avoiding too high a temperature, the residue was dissolved with HCl. water, the solution after filtering saturated with H_2S and then allowed to stand for 12 hours in a warm place.

The resulting precipitate was then washed in the filter, sulphate of potash* containing yellow polysulphide was poured over it, and then it was left for some time in soft heat for interaction to take place, so as to separate tin sulphide from the sulphides of the copper group. It was then filtered, the filtrate soured a little, and the resulting sulphur, consisting of a mixture of sulphur and tin sulphide, was burned in a suitable porcelain boat, whereby it was evaporated several times with concentrated nitric acid in order to cause complete oxidation of the residue.

A white residue remained when tin was present, which, when weighed, enabled an opinion to be formed as to the approximate amount of tin present in the sugar. An exact quantitative estimation of a contamination that only runs to thousandths per cent., is of course out of the question.

* Because some of the sugar contained a fair amount of copper.

The four tested English colonial sugars gave the following results:—

DESCRIPTION OF SAMPLES.

	Ash. Per cent.		Tin Chloride. Per cent.
Yellow post	0·76	....	0·0112
White post	0·32	....	0·0014
Molasses sugar for direct consumption ..	2·90	....	0·042
Dark crystals for American market ..	0·47	....	0·01

The tin was of course not weighed as chloride but identified as tin oxide in the manner described subsequently and the remainder calculated as chloride.

As a further test for proving the existence of tin, a mixture of tin and tin sulphide was after drying removed from the filter and then carefully burnt white in a porcelain boat. The residue was then weighed. Next the boat was placed in a tough glass tube through which a stream of hydrogen gas was led in such a way that the gas stream passed from the tin oxide to the empty end. On heating the boat with a triple burner, the tin oxide was reduced to tin that was visibly of a very dark colour and in the part where it lay covered the surface of the boat. One thus obtained a striking contrast in colour.

No trace of arsenic was established either in the weaker heated portion of the porcelain boat or at the cooler end of the glass pipe, moreover the complete solubility of the regulus in the hydrochloric acid prevented any permutation with other metals of the sulphate of ammonia group, antimony, platinum, gold. Finally a drop of hydrochloric acid was placed on the trace of tin, it was sucked up with a capillary tube and placed in a solution of mercuric chloride whereupon it was reduced to mercurous chloride, which appeared in sufficient quantity so that on the application of ammonia it gave a strong black colouring,

The tests on raw sugar of German origin must also be mentioned. These were carried out in exactly the same manner, and not the smallest precipitate of sulphuretted hydrogen was found apart from some sulphur precipitated by the salts of iron oxide; this last remaining behind on the filter was treated with a similar amount of sulphate of potash (like the sulphuretted hydrogen precipitates of English sugar), the solution of potassium sulphate was precipitated with hydrochloric acid, the resulting residue was burnt, and both by the weighing of the eventual residue, as well as by the heating in the stream of hydrogen gas, the experiments gave negative results, and the complete absence of tin was established.

It is reported that Mr. Hamakers of Java has gone to Hawaii at the invitation of the Hawaiian Sugar Planters' Association with a view to introducing some of the Java methods in the sugar industry, as well as to arrange for a trial of the new Geerligs-Hamakers process of extraction.

THE NECESSITY OF CHEMICAL CONTROL IN THE DISTILLERY.

By M. F. Verbièse.

(Continued from page 241.)

3. *The Fuel.*

Certain distillers have the excellent habit of reckoning exactly what each hectolitre of alcohol costs them to make; this total is moreover subdivided under well-defined headings, such as staff, acid, fuel, &c. Nothing is more useful than this classification, for each year the distiller may thus ascertain why the general expenses increase or diminish, and take the necessary steps to remedy the partial increases taking place daily. Now, if one compares the costs of manufacture thus detailed of several usines, we are surprised at the enormous differences under the heading of "fuel."

Certain distilleries use per hectolitre of product fully one-third more coal than their neighbours. What is the cause of this anomaly? The cause, or rather the causes, are rather complex:—(*a*) The quality of the fuel; (*b*) The more or less perfect utilization of the heat produced; (*c*) The efficiency of the machinery; (*d*) The economy of heat in practical working. A word on each of these points.

(*a*) *The Quality of the Fuel.*

Now that every sugar factory rigorously analyses the coal, the coke, the limestone, and, in general, everything that is bought, how many distillers take the trouble to have their coal analysed? In seeking to reduce the cost of fuel it is naturally of primary importance to enquire as to its quality. It may be objected that if the quality be inferior, the cost is lower, and thus the price per unit of heat should be the same. This should be, but is not always the case, and we have at times seen distillers paying dearly for quite second-rate coal, rich in ash. The above mentioned precaution is sometimes very useful, and is never superfluous.

(*b*) *The more or less perfect Utilization of the Heat produced.*

Here again are differences between one usine and another as regards the calories wasted or lost.

Sometimes it is a bad stoker who shovels in too much coal at a time, and loses its heating value in the form of black smoke; there it is due to defective fire bars, which allow the ashes to be too carbonaceous, or to the boilers themselves which, being of an old-fashioned type, do not permit the utilization of the heat evolved; again, it is due to the hardness of the feed-water which coats the interior surfaces of the boilers with a scale which, gradually increasing, also prevents the perfect utilization of the available heat.

(c) *The Efficiency of the Machinery.*

It is well known that certain machines consume a greater amount of heat than those of a more perfect type to produce the same amount of useful work; but this point is outside the subject of our present study.

(d) *The Economy of Heat in Practical Working.*

We have noted that the quantity of juice drawn from the battery may often be reduced; on the other hand, large quantities of the (hot) spent wort may be utilized in the work; so much the more heat will be economised.

The saying that "nothing is lost, nothing self-created" is of special applicability in this matter of heat. If the distiller is quite convinced of the truth of the second part of this saying from the point of view which now occupies us, he cannot but perceive that the first cannot be applied to his case, and that to his cost. Therefore he will endeavour to reduce this loss by every means in his power.

4. *The Working Plant.*

We shall pass rapidly over this subject which goes beyond the limits we have set ourselves. This point deserves much attention however; certain distilleries are equipped with old-fashioned or much deteriorated appliances, and a study of the improvements which might be effected would be of great interest, but principally concerns the engineers; we limit ourselves to indicating its necessity.

5. *The Fermentations.*

In many distilleries fermentation is set up by mixing a large quantity of yeast in the juice of the beetroot, then, when the fermentation is well established, more juice is gradually added until the vat is full; when the work is in full swing, several vats are kept going at one time, a new one being started when the last has been filled, all the vats in filling communicate with each other: this is the method adopted in distilleries where brewers' yeast is employed.

In certain usines this yeast has been abandoned because its purity is always doubtful; on the assumption that to obtain a perfectly pure fermentation it is necessary that the starting point or yeast should itself be perfectly pure, selected yeasts are employed which are carefully cultivated under conditions which prevent contamination. The inconvenience of employing these pure yeasts lies in the necessity of a special and rather costly material and special vats of various capacities.

Moreover, the precautions which must be taken to prevent contamination of the yeasts are too special and difficult for the average distiller.

Another complaint made of this system is that the fermentation cannot be rendered aseptic towards the end. The juice of the beet,

particularly at certain seasons, contains numerous bacteria and wild yeasts, the spores of which are able to more or less resist the imperfect pasteurisation produced in the apparatus where the pulps are macerated. Consequently, assuming that contamination by exterior germs may be prevented, one cannot avoid the contamination caused by those contained in the juice itself.

If that portion of juice, necessary for the development of the yeast at starting be perfectly sterilised—which entails a considerable cost in fuel—and although the yeast be perfectly pure, yet, by the time the vat is filled the whole volume of juice will be decidedly infected because the diluting juice comes direct from the presses, the maceraters or diffusers, passing through the coolers, gutters, pumps, &c., which are too often "nests" of bacteria.

It will be evident that such contamination will be indicated in a manner the more apparent as the juice itself is the more deteriorated, but a strictly aseptic system of fermentation could never be applied in practice to the working of beets. This is why an observation we have heard made does not lack a certain degree of truth : "For what purpose do we strive to prevent the introduction of any foreign ferment to our yeasts which are preserved in a state of purity by the aid of costly installations and minute precautions, if the said pure yeasts are to be eventually mixed with a considerable quantity of unsterilized juice?"

The partisans of this system reply, with some reason, that in thus starting each vat with a pure yeast, although the initial purity of the fermentation cannot be maintained to the end it will always be less inferior than in the old system in which the contamination, even momentary, of a vat may infect all those which follow up to the time that the work is started afresh.

But if the fermentation under aseptic conditions is not completely applicable in the beet distillery, there is nothing to prevent the adoption of antiseptic media, that is to say, to render the juice unsuitable to the growth of bacteria by the addition of appropriate antiseptics. Already, sulphuric acid has been found to have a powerful preservative action, but other agents, hydrofluoric acids and the fluorides, amongst others, possess this property in an infinitely greater degree.

During the last campaign, we had an opportunity of testing the antiseptic action of compounds of fluorine under special conditions.

Generally, when antiseptics are employed, the pure yeasts are "acclimatised" or rendered indifferent to the presence of large quantities of hydrofluoric acid so that the proportion of this acid, added to the juice to be worked, may be more or less elevated without hindering the activity of the yeast which has been previously grown in media containing much larger quantities of this antiseptic.

But in this instance it was a case of fermentation with ordinary brewers' yeast, in juice containing the butyric ferment. The fermentation was active, but impure, notwithstanding the large quantity of sulphuric acid employed. It occurred to us to try the effect of a small addition of a fluoride, which immediately produced an antiseptic effect, enabling us to reduce the proportion of sulphuric acid by one gram per litre.

Now, the quantity of fluoride with which we were working was only from 0·01 to 0·015 gram per litre of wort. We attempted to increase this proportion, but the fermentation slackened and became feeble, so that we were obliged to stop the addition of fluoride for several hours, when the fermentation resumed its normal activity. We repeated this experiment with the same result, and were thus obliged not to exceed this small proportion otherwise the yeast itself was affected by the presence of this antiseptic.

Now, as when dealing with very impure juices from roots which, for example, have been frozen and subsequently thawed, a proportion of from 3 to 6 grams per hectolitre is often necessary, it follows from the above experiment that ordinary brewers' yeast will not serve and that it is necessary to employ yeasts which have been "acclimatised" to this antiseptic.

Those yeasts which M. Effront has cultivated in wort containing 36 grams and more of the pure acid per hectolitre, remain quite unaffected in wort containing 3·6 and even 12 grams of hydrofluoric acid per hectolitre.

In such relatively enormous proportions the most active bacteria are rendered inactive.

The solution of the problem of pure fermentation in the distillery appears to us, therefore, to consist in the use of pure yeast "acclimatised" to antiseptics, and in the judicious employment of these latter in the fermenting vats.

This system of fermentation in an antiseptic media presents the great advantage of requiring no special installation for its application, the old or new system of working can be employed at will, moreover, precautions and special attention to cleanliness are not more essential than in the ordinary working, we would almost state that on the contrary cleanliness is not altogether to be recommended.

In addition to the advantages of always obtaining a pure fermentation and increased yield of alcohol of good flavour, the use of antiseptics permits of a greatly reduced consumption of sulphuric acid. Finally, from the point of view of faulty fermentations, which it completely suppresses by destroying the cause, it gives an absolute security, which we have seen is of no small value.—*(Bull. de l'Assoc. des Chimistes.)*

Germany.

The British Consul-General reports:—As a consequence of the Brussels Convention the Sugar Law of 1896 was repealed and a new law embodying the stipulations of the convention has been promulgated. Under the old law the German import duty on foreign sugar was £2 per 100 kilos., while on sugar intended for export a premium of 2s. 6d. to 3s. 9d. per 100 kilos. was granted according to the amount of saccharine matter it contained. German sugar manufactured for home consumption was subject to a tax of £1 per 100 kilos., while the exported sugar was exempted from this tax. Each sugar factory was allowed to produce a certain quantity of sugar, any excess of which was subject to an additional tax.

Under the new law the export bounties are abolished, and the tax on inland sugar is reduced from £1 to 14s. per 100 kilos. The import duty, which formerly was £2 (£1 inland tax plus £1 surtax), is reduced to 4s. 10d. and 4s. 5d. respectively. Foreign imported sugar is therefore subject to a duty and tax amounting in all to 18s. 10d. and 18s. 5d. respectively. The limitation of sugar production is also abolished under the new law.

Since the Brussels Convention came into force (September 1st, 1903) the German sugar market has undergone considerable changes. Under the old regime the German sugar industry depended to a large extent on the export trade. The monopoly formerly enjoyed by beetroot sugar is contested by cane sugar, which now competes with a much better chance of success than heretofore. The German sugar industry, therefore, must pay greater attention to the home market in order to find an equivalent for its diminished export trade. The reduction of the home sugar tax by 6s. per 100 kilos. and of the "surtax" (Ueberzoll) by more than 15s. per 100 kilos. to 4s. 10d. and 4s. 5d. has already led to a corresponding fall of the home prices, and in consequence a considerably higher consumption is expected. The prevailing retail prices have so far kept the consumption at a very low standard and materially hampered the development of the marmalade and preserved fruit industry. It has been found impossible to maintain the Sugar "Cartel" under the changed conditions. This syndicate was organised on the basis of the Law of 1896, and endeavours to adapt it to the new state of things have failed. The old feuds between factories and refineries, which had never been settled to universal satisfaction, broke out afresh, and the conflict led to the dissolution of the syndicate at the end of 1903.

Netherlands.

Amsterdam.—The coming into force of the Brussels Sugar Convention on September 1st, 1903, has placed the sugar market at last in a sounder position, but its effects have not yet made themselves fully felt. More confidence is felt in the future of the article, but considering the

size of the stocks and the prospects of increased production in the present year, there is not much chance of any serious improvement in prices. This can only be expected from a diminution in the production, and it remains to be seen what effect the convention will have on the German beet sugar producers, after the dissolution of the sugar cartel in that country. The total importation in the Netherlands in 1903 amounted to 214,088 tons, as compared with 226,998 tons in 1902.

RUSSIA.

Warsaw.—The prospects of the sugar factories were not at all bright at the beginning of this season on account of the failure of the beet crop. Before the end of the preceding sugar season stocks of sugar were exhausted and prices went up, but declined again when sugar was brought from Kieff. The Brussels Convention, which renders the export of Russian sugar impossible to countries which belong to the Convention, has a depressing effect on the industry.

SPAIN.

The cultivation of beetroot and its conversion into sugar was begun in the provinces of Santander, Burgos, and Logrono after the loss of the Spanish colonies. So many factories were opened and provided with expensive machinery, that the supply soon outran the demand, and disaster followed in many cases. Trusts were then formed in order to maintain the price of sugar, which is high. The sugar cane growers in Southern Spain did not join these Trusts, but they eventually came to terms, by which the beet sugar producers engaged to supply 80,500 tons annually, whilst the others were to put out 9,500 tons, thus making between them a production of 90,000 tons, an amount estimated to cover the consumption of sugar in Spain.

TURKEY.

Alexandretta.—The quantities and values of sugar imported into Alexandretta during the years 1902 and 1903 were as follows:—

1902.			1903.			Average of five years.	
Quantity.	Value.		Quantity.	Value.		Quantity.	Value.
Tons.	£		Tons.	£		Tons.	£
4,137	45,635	....	3,210	36,780	....	3,441	40,798

It came mostly from Russia and Austria-Hungary.

CHINA.

Hankow.—Net imports of sugar into Hankow during 1903 and 1902.

1903.			1902.		
Cwts.		£	Cwts.		£
270,475	..	148,905	387,745	..	205,661

The native imports into Hankow for same period were:—

	1903.			1902.	
	Quantity.	Value.		Quantity.	Value.
Sugar.	Cwts.	£		Cwts.	£
Brown	179,716 ..	84,604	....	221,594 .	99,212
White	151,075 .	94,980	....	160,082 ..	101,390

Swatow.—Exports of native sugar during 1902-3:—

	1902.			1903.	
Sugar.	Cwts.	£		Cwts.	£
Brown	762,219 ..	288,330	....	703,366 ..	299,712
White..	534,536 ..	307,217	....	501,220 ..	323,001

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. THOMPSON, C.E., F.C.S., M.I.M.E., Chartered Patent Agent, 6, Lord Street, Liverpool ; and 322, High Holborn, London.

ENGLISH.—APPLICATIONS.

7089. S. STEIN, Liverpool. *Improvements in the manufacture of invert sugar.* 24th March, 1904.

8554. C. F. CROSS, London. *Improved manufacture of a crystalline sugar.* 13th April, 1904.

9355. F. HOLL, London. *Apparatus for cooling and drying granular materials, such as moist sugar and the like.* 23rd April, 1904.

10664. M. F. EWEN and G. H. TOMLINSON, London. *Process for converting wood cellulose into sugar.* (Complete specification.) 9th May, 1904.

ABRIDGMENTS.

6925. M. DE MARCHÉVILLE, Paris, France. *Improvements in hydro-extractors.* 25th March, 1903. This invention relates to a centrifugal hydro-extractor, whereof the basket or drum is in the form of a truncated cone, the bottom being at the larger base whilst the smaller base is entirely open and, unlike the usual form, devoid of internal flange, thus permitting of the employment of an extractor, having simply an alternating rectilinear movement and capable of passing completely out of the drum, which, in consequence of its truncated conical form, will retain the material under treatment notwithstanding the absence of any internal flange.

9308. J. GLASS and R. GLASS, Leipzig, Germany. *Improvements in vacuum drying and evaporating apparatus.* 24th April, 1903. This invention relates to drying and evaporating apparatus, in which the material to be dried falling from the endless heated bands, is conveyed, whilst passing round the heating surfaces arranged below, to a collecting or removal chamber, from which it is discharged from time to time. The material falls, as soon as it is dried, from the heating surfaces, and is then withdrawn from the action of the heat, which would thenceforth only be prejudicial.

GERMAN.—ABRIDGMENTS.

147675. HANUS KARLIK and JAN CZAPIKOWSKI, Nymburk, Bohemia. *A horizontal vacuum boiling down apparatus having heating pipes revolving over its bottom.* 8th June, 1902. The horizontal vacuum apparatus in this invention is provided with a boiling down and mixing apparatus which revolves directly over its bottom. This apparatus consisting of heating pipes formed as mixing arms, and stiffened in the middle by cross plates. In the boiling down apparatus, more particularly, "masse-cuites" are boiled down to 3 to 4% of water contents, and all the crystallisable sugar is obtained

from the so-called green syrup, with a maximum molasses quotient of 60.

147931. FRANZ NOWAK, Roswadze, Upper Silesia. *An ejecting punch for sugar stick presses.* March 25th, 1902. The invention relates to an ejecting stamp for sugar stick or strip presses, and more particularly for such as are described in Pzillas' (German Patent No. 8156). It is distinguished by the front face of the punch or stamp being provided with a metal cover and the stamp or punch itself having hollow chambers, which at the time of the return movement of the ejecting stamp are brought into communication with a compressed air container, preferably by means of a tap operated by the movement of the stamp itself. The object of this arrangement is to produce perfectly smooth strips.

148029. EDMOND LONMEAU, Plaines-Wilhelms (known as Curepipe), Mauritius. *Process and apparatus for treating sugar juice.* 31st October, 1900. The process is intended to obtain sugar by allowing the sugar juice to freeze, and consists in operating the freezing of the previously purified sugar juice by means of liquid air. The apparatus employed for carrying out the process is a series of tanks surrounded by a coil of pipes perforated with holes and enclosed by an outer casing, and communicating by means of pipes with one another, the said pipes being also connected with the coil.

148084. LUDWIG LORENZ, Dormagen. *A beetroot shredding machine having vertical slicing discs.* March 26th, 1903. A partition which gradually widens from the place where the beetroot is inserted to its end, is located between two vertical slicing discs so that the beetroots are pressed by this partition against the slicing discs when the latter rotate.

148327. HANUS KARLIK and JAN CZAPIKOWSKI, Nymburk, Bohemia. *Cooling, heating and mixing pipes for mashing.* December 6th, 1902. The peculiarity of this invention consists in the pipes being arranged in spiral lines, but not set opposite to one another, *i.e.*, somewhat zigzag fashion.

148354. RUDOLF FÖLSCHE, Halle, o/S, and FRANZ NOWAK, Roswadze, Upper Silesia. *An improved arrangement for columnar crystallisation vessels.* May 21st, 1902. This invention relates to columnar crystallisation vessels for plain masse-cuite or masse-cuite boiled to grain, in which apparatus, fully crystallised masse is drawn off from time to time beneath, and fresh liquid sugar stuff introduced above correspondingly. The apparatus consists of a columnar crystallisation vessel by means of which such a composite movement of the parts is produced and maintained in the mass whilst maintaining its layers as far as possible, that these particles are displaced from the periphery to the centre and again from the centre to the periphery. The crystallisation vessel is of the high columnar type described in German Patent, No. 99441, provided with a stirring

mechanism at its lower part. A shaft is prolonged into the upper part of the vessel and set, in zones, with arms carrying scrapers at their outer ends for scraping the masse from off the walls of the column and pressing it downwards; these scrapers being combined at intervals with obliquely directed scrapers which impart to the mass a movement towards the centre. Inclined scrapers are also so arranged at suitable intervals in the centre of the shaft, that they impart to the masse a movement towards the periphery.

148668 AUBIN OLLIER, Bordeaux. *A process for making dry masse-cuite.* 10th October, 1901. A grain masse-cuite obtained in the boiling down apparatus by means of a vacuum of ·37 to ·33 metres by the mercury column, and not containing above 9% of water, is dried in a mashing apparatus at an initial temperature of from 98 to 99°, and at a vacuum of about ·70 metres, being thoroughly stirred at the same time by means of a stirring apparatus.

148748. Dr. HEINRICH WINTER, Charlottenburg. *Means for sharply separating drainings of different composition inside the centrifugal.* December 25th, 1904. The separating mechanism described in the original Patent No. 137297 has the drawback that in constructing the separating arrangement in existing centrifugals in which only a narrow space is left available between the drum and the casing, the auxiliary casing must be made of a somewhat considerable number of strips, thus affecting the simplicity of the apparatus. The present arrangement for separating the drainings of different composition avoids this difficulty by allowing the number of strips or blades to be limited at will. This is attained by the strips not being revoluble on a vertical axis, but laterally displaceably arranged, so that they may be alternately exposed to the centrifugalled liquid or removed therefrom, passing behind the next adjacent blade or strip. All the blades may be made movable relative to one another or the even ones may be firmly mounted, and the uneven ones displaceably mounted (or *vice versâ*).

149019. HANS MATHIS, of Ottleben. *Apparatus for the automatic uninterrupted saturation of sugar juice and the like.* 9th January, 1903. This apparatus has, in combination with the saturation vessel, an oblique discharge aperture adjustable by hand, and a float opening or closing the inlet tap for the saturation gas corresponding to the actual height of the juice in the vat, with the object, even in the case of a frequently-varying inflow of juice, of enabling the juice to be adjusted by means of the outlet aperture to a suitable alkalinity which is maintained at a constant degree by means of the float.

149020. RICHARD SCHRADER, Charlottenburg. *A method of, and apparatus for, cleaning crude starch milk by centrifugalling.* February 13th, 1902. A row of strongly tapering centrifugal agitating vats arranged one above the other, in which vats large beaters rotate rapidly, for instance, at a speed of from 50 to 200 revolutions per

minutes, are fed with crude starch milk at one end, and the cleansing water at the other. The starch milk coming from the first, and the cleansing water mixed with the partly used water, travel under the action of centrifugal force through the row of vats in opposite directions. The starch milk is condensed in each vat, and again diluted with the drain of the next vat, and finally is discharged from the last vat in a concentrated form.

149053. OSCAR GIEFER, of Schöneberg, near Berlin. *Apparatus for preparing beetroot for slicing.* May 20th, 1903. The beetroot is first thoroughly cleansed from the adherent earth in a washer provided with stirrers, and pushed into an obliquely inclined worm conveyer by a cross arm mounted on the shaft of said conveyer. They float on the water, and are gradually removed therefrom by the worm conveyer. Any small stones which may chance to be carried along with them roll down again into the wash tub, along the inclined trough of the conveyor, the larger stones having of themselves remained on the floor of the tub. Water flows constantly through the tub, and washes away the particles of dirt.

149380. Dr. HEINRICH WINTER, Charlottenburg. (Patent of addition to Patent No. 147627 of 28th February, 1902.) *A process for making from beetroot sugar products resembling cane sugar.* 31st October, 1902. The invention relates to an improvement in the process described in the original patent above-mentioned, and consists in the use of ammonia, caustic baryta, or caustic strontia, for making a decomposed solution of invert sugar or other hexose.

149533. Dr. HEINRICH WINTER, Charlottenburg. *A catch casing for centrifugals for separating the drain.* 4th October, 1902. The separation of the drain takes place by means of a catch casing which is formed wholly or partially of flexible material such as canvas, india-rubber, or the like, so that a closed tubular hood or cover is formed, which is capable of being folded up.

IMPORTS AND EXPORTS OF SUGAR (UNITED KINGDOM)

To end of April 1903 and 1904.

IMPORTS.

Raw Sugars.	Quantities.		Values.	
	1903.	1904.	1903.	1904.
	Cwts.	Cwts.	£	£
Germany	1,239,725	2,315,978	492,684	993,685
Holland	104,359	64,621	39,233	25,597
Belgium	307,758	91,822	126,691	36,551
France	134,349	86,964	62,432	38,592
Austria-Hungary	1,066,414	593,670	447,168	269,101
Java	....	685,023	....	290,781
Philippine Islands	70,646	....	25,285	....
Peru	64,922	289,296	24,488	127,736
Brazil	40,538	75,266	15,882	28,747
Argentine Republic	72,515	....	32,339	....
Mauritius	162,036	158,680	57,092	59,258
British East Indies	57,366	44,348	21,804	18,656
Br. W. Indies, Guiana, &c.	219,830	363,031	140,355	233,926
Other Countries	104,226	249,790	44,670	113,778
Total Raw Sugars	3,644,684	5,018,489	1,530,123	2,236,408
Refined Sugars.				
Germany	4,120,743	3,326,908	2,126,654	1,845,489
Holland	641,978	1,059,564	371,795	617,684
Belgium	52,875	136,053	31,640	75,902
France	259,369	805,487	152,511	69,726
Other Countries	361,439	156,953	179,107	82,845
Total Refined Sugars	5,436,404	5,484,965	2,861,707	3,051,646
Molasses	508,928	520,213	96,429	97,072
Total Imports	9,590,016	11,023,667	4,488,259	5,385,126

EXPORTS.

British Refined Sugars.	Cwts.	Cwts.	£	£
Sweden and Norway	7,164	7,765	3,787	4,441
Denmark	26,515	40,858	13,746	20,962
Holland	19,521	19,434	10,604	10,190
Belgium	2,813	3,412	1,372	1,905
Portugal, Azores, &c.	2,119	3,180	1,164	1,762
Italy	3,602	1,727	1,631	810
Other Countries	154,489	104,542	93,629	64,671
	216,223	180,918	125,933	104,746
Foreign & Colonial Sugars.				
Refined and Candy	8,137	7,721	5,401	5,500
Unrefined	15,283	34,786	7,943	19,005
Molasses	174	94	76	37
Total Exports	239,817	223,519	139,353	129,288

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1904. Tons.		1903. Tons.
Total Receipts, 1st Jan. to May 19th ..	782,662	..	675,281
Receipts of Refined ,, ,, ,, ..	125	..	341
Deliveries ,, ,, ,, ..	772,268	..	623,981
Consumption (4 Ports, Exports deducted) since 1st January	654,232	..	555,702
Importers' Stocks (4 Ports) May 18th ..	22,555	..	55,685
Total Stocks, May 25th	205,000	..	284,336
Stocks in Cuba ,, ...	226,000	..	358,244
	1903.		1902.
Total Consumption for twelve months ..	2,549,643	..	2,566,108

CUBA.

STATEMENT OF EXPORTS AND STOCKS OF SUGAR, 1903 AND 1904.

(Tons of 2,240lbs.)	1903. Tons.		1904. Tons.
Exports	342,395	..	637,070
Stocks	398,442	..	266,915
	740,837	..	903,985
Local Consumption (four months)	14,880	..	15,000
	755,717	..	918,985
Stock on 1st January (old crop)	42,530	..	94,835
Receipts at Ports up to April 30th ..	713,187	..	824,150

J. GUMA.—F. MEJER.

Havana, April 30th, 1904.

UNITED KINGDOM.

STATEMENT OF IMPORTS, EXPORTS, AND CONSUMPTION FOR FOUR MONTHS ENDING APRIL 30TH.

SUGAR.	IMPORTS. 1904. Tons.	1903. Tons.	1902. Tons.	EXPORTS (Foreign). 1904. Tons.	1903. Tons.	1902. Tons.
Refined	274,248	271,820	459,402	386	407	570
Raw	250,924	182,234	325,130	1,739	764	1,082
Molasses	26,011	25,446	19,725	5	9	54
Total	551,183	479,500	804,257	2,130	1,180	1,706

	HOME CONSUMPTION. 1904. Tons.		1903. Tons.		1902. Tons.
Refined	292,711	..	252,364	..	465,619
Raw	42,500	..	170,515	..	341,287
Molasses	26,321	..	25,959	..	22,797
Total	361,532	..	448,838	..	829,703
Less Exports of British Refined	9,046	..	10,811	..	10,544
Home Consumption of Sugar imported from Abroad..	352,486	..	438,027	..	819,159
,, ,, ,, Refined (in Bond)	172,758	..	—	..	—
,, ,, Molasses, manufactured (in Bond)	21,601	..	—	..	—
Total Home Consumption of Sugar	546,845	..	438,027	..	819,159

Stocks of Sugar in Europe at uneven dates, May 1st to 25th, compared with previous Years.

In thousands of tons, to the nearest thousand.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	Total 1904.
95	1051	681	408	234	2470

	1903.	1902.	1901.	1900.
Totals	2487 ..	2591 ..	1810 ..	1674

Twelve Months' Consumption of Sugar in Europe for Three Years, ending April 30th, in thousands of tons.

(From Licht's Monthly Circular.)

Great Britain.	Germany.	France.	Austria.	Holland, Belgium, &c.	Total 1903-4.	Total 1902-3.	Total. 1901-2.
1752	958	634	447	510	4300	3724	4107

Estimated Crop of Beetroot Sugar on the Continent of Europe for the current Campaign, compared with the actual crop of the three previous Campaigns.

(From Licht's Monthly Circular.)

	1903-1904.	1902-1903.	1901-1902.	1900-1901.
	Tons.	Tons.	Tons.	Tons.
Germany	1,950,000 ..	1,762,461 ..	2,304,923 ..	1,984,187
Austria	1,165,000 ..	1,057,692 ..	1,301,549 ..	1,094,043
France	790,000 ..	833,210 ..	1,123,533 ..	1,113,893
Russia	1,200,000 ..	1,256,311 ..	1,098,983 ..	918,838
Belgium	210,000 ..	215,000 ..	334,960 ..	333,119
Holland	125,000 ..	102,411 ..	203,172 ..	178,081
Other Countries.	410,000 ..	325,082 ..	393,236 ..	367,919
	5,850,000	5,552,167	6,760,356	5,990,080

THE

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☞ All communications to be addressed to The Editor, Office of *The Sugar Cane*, Altrincham, near Manchester.

All Advertisements to be sent *direct*.

Cheques and Postal Orders to be made payable to Norman Rodger, Altrincham.

☞ The Editor is not responsible for statements or opinions contained in articles which are signed, or the source of which is named.

NOTES AND COMMENTS.

The Java Sugar Crop.

As far as the results of this year's crop are known, the season is turning out a very profitable one for Java. The tonnage of the cane is much above the average, and the sucrose content remarkably high, giving expectations of a high sugar return this year. No serious diseases are reported, and there is every reason to believe that the 1904 crop will become a record one.

The Queensland Central Mill System.

When, some years ago, central sugar mills were started in Queensland, with the aid of loans from the Government, the outlook seemed promising, especially when Dr. Walter Maxwell, of Hawaiian fame, had been appointed a Director of the Sugar Experiment Stations. But as year after year some or other of the mills failed to pay the interest on loans, it began to be realised that there was something radically wrong in the system pursued. Briefly, the Government appear to have kept too lax a hold on the defaulting mills; and for want of a central organisation with an expert at its head, each mill seems to have been allowed to "gang its ain gait" in the matter of expenditure, processes, and labour arrangements. Thus while one mill may have adopted labour saving devices, the others continued with the older and more costly systems; again, one mill may have been well supplied with cane, while another may have suffered from a scarcity of supplies.

The remedy suggested is to combine all the mills under a Central Mills Bureau, which latter will be a Government office attached to the Treasury. Dr. Maxwell has been re-engaged for a further period of three years to exercise complete control over the administration of this Bureau. He will thus be Controller of the Central Sugar Mills as well as Director of Sugar Experiment Stations. The expenses of his department will no longer be paid from a tax levied on the industry, but will be provided for out of the Treasury.

It is hoped that the new arrangements, under which the State is taking up its true position as an active co-partner in the control of all the mills which are in arrears to the Treasury, will lead to a condition of affairs more satisfactory to both parties. This co-operation between the Government and the mill directorates will be on the lines laid down in Dr. Maxwell's report, and will deal with the securing of adequate supplies of cane for the mills, together with the technical management of the mills; also with matters relating to extensions and additions to mill plants; with the fixing of the price to be paid for cane; with the sale of sugars; and will answer all questions of a financial character concerning the mill companies. This should prove a far more satisfactory arrangement, as Dr. Maxwell's great knowledge and wide experience will now have full scope, and no petty animosities amongst mill staffs will be allowed to interfere with the needed improvements. Dr. Maxwell's re-engagement will also allow him the opportunity of completing the series of cultivation and fertilising experiments he has been engaged on for some time past. Altogether, the new arrangement promises a brighter future for the Queensland Central Mills, and we trust these endeavours will meet with the success they deserve.

The Manchester Chamber of Commerce and Sugar.

The Manchester Chamber of Commerce has lately added to its list of Sectional Committees one called the "Sugar Section." If it were intended to watch the interests of all sections of the sugar industry, producers, manufacturers, and consumers, with an all round impartiality, it would doubtless render useful service to the whole community. But a glance at the names composing the committee gives one the undeniable impression that only the interests of the consumer (especially the wholesale confectioner), are to be considered, and that the main policy will be to worry the Government into repealing the sugar tax; also to misrepresent the purpose and effects of the Brussels Sugar Convention, as was done at a recent Chambers of Commerce conference by one or two bodies. If our surmise proves correct, then we doubt whether any real good will ensue. There was a time when Manchester had at least two sugar refineries at work; did they exist to-day they would have a claim to be represented on

the sectional committee and would give it a more comprehensive character. But as matters now stand, the committee cannot lay claim to serving any other than purely local interests, and any pronouncement on their part will not have the wide influence that resolutions coming from some of the other sections of the Chamber obtain.

U.S.A. Polariscope Case decided.

The United States Circuit Court of Appeals on June 2nd handed down a decision in favour of the government in the case of the United States *vs.* Bartram Bros., B. H. Howell, Son & Co., and the American Sugar Refining Company.

These cases were originally decided by the Board of United States General Appraisers in favour of the government. The importers appealed and carried the case to the United States Circuit Court, which decided in the importers' favour. Then the government carried the case to the United States Circuit Court of Appeals. These cases involved the method of employing the polariscope to determine the saccharine strength of sugar upon which the import duty of sugar is based. The importers claimed that Congress intended that the commercial test should be used to determine the classification of imported sugars, while the government officials used a particular polariscopic test, which stipulated that the temperature of the room in which the test was made must be ascertained, and the strength of the sugar decided by adding or deducting an equivalent number of degrees, according to the amount which the temperature of the room was over or under 25 degrees centigrade. The government's reason for the latter test is that the degrees of sugar will vary according to the temperature in which the polariscopic test is made. It is reported that the cases will be appealed to the United States Supreme Court. The difference in the rates of duty as determined by the two different methods is said to amount to about 35-1000 of a cent per pound against the importer.—(*Willett & Gray's Circular.*)

A Sugar Institute at Liverpool.

We learn that Mr. Sigmund Stein, so well known for his labours in the cause of a British beet sugar industry, is starting a Sugar Institute at Liverpool with a view to giving advice on all matters pertaining to the sugar industry. Parties wishing to acquire a knowledge of the subject will, doubtless, also be given instruction in the different branches of the industry. Further particulars can be learnt from a perusal of the advertisement appearing on page XV., or by communicating direct with Mr. Stein, at 214, Upper Parliament Street, Liverpool.

THE RELATIVE MERITS OF CANE AND BEET SUGAR.

Since the passing away of the bounty system, thanks to the operations of the Brussels Convention, there has been a natural revival in the cane sugar industry. This has led to a renewal of the old controversy as to whether cane or beet sugar is the superior as regards sweetening and nutrient powers. The American beet sugar papers seem largely responsible for this fresh outbreak. They, doubtless fearing that the competition of cane sugar was going to prove more serious than ever, adopted a new line of opposition, and attempted to depreciate the advantages claimed for cane sugar.

To this effect one of these organs made an attack on Demerara sugar, and took pains to prove, what nobody had seriously attempted to deny, that this sugar contained minute quantities of tin, owing to its being prepared with bloomer. But the further insinuation that this tin present in the sugar constituted a poisonous element, and had probably been the real cause of death to some English bees which had been fed with "genuine Demerara" sugar, is entirely unjustifiable, and suggests that the writer of the article was in an extremely irritable state of mind when he made his attack on the rival commodity. The bee story has appeared in our *Journal* already. The facts were that the bees were fed with what was alleged to be *genuine Demerara*, but proved on analysis to be beet crystals, probably treated with aniline dyes. No wonder, then, the bees refused to eat them. There was no doubt from the analysis that the sugar in question was *not* Demerara cane, so the allegation that the tin present in the latter was the real cause of the mischief, and that a case was trumped up against beet sugar in order to hide the delinquencies of cane is merely a puerile attempt to get over some awkward facts. There is plenty of evidence to prove that bees will eat cane sugar and yet refuse beet. A letter appearing recently in the *British Medical Journal*, and reproduced in our columns last month, makes a decisive statement on this point. The writer, moreover, affirms that he has been long convinced that with consumptives and children the nutrient fattening power of ordinary grocers' beet sugar is nil. On the other hand, when real cane sugar —preferably in the uncrystallized state—was used improved results were noticed. This apparent superiority has been corroborated by the testimony of other medical men, and it is not to be easily explained away.

As regards the charge levelled against the use of tin salts in the turning out of Demerara crystals, it is not to be denied that if the "bloomer" employed be made from impure chemicals, injurious

foreign substances may find their way into the sugar; but is there any evidence to show that such a contingency occurs otherwise than very exceptionally? An analogous case may be cited in the beer poisoning scare which took place in Lancashire a few years ago, where, owing to some brewing sugars being inadvertently made from impure sulphuric acid, a considerable amount of arsenic got into the beer with fatal results. Yet it was not suggested that the use of brewing sugars in the manufacture of beer was an undesirable feature. And it has not been shown that pure tin salts have any deleterious effect when present in cane crystals. Dr. Urich, of Trinidad, a private consulting chemist, has shown* that, from tests made by him, the amount may be as little as 0·1 gr. per lb. of sugar; but even supposing 0·3 or 0·5 gr. should be more usual, as stated by Dr. Stevenson, a member of the Arsenic-in-Beer Commission, the habitual consumption of such sugar has no injurious results. The same American beet journal notes with satisfaction that in an analysis made by Dr. Pitsch, of Germany, in the Vereins laboratory he established the presence of tin in several samples of Demerara sugar and assumed that it arose from the employment of "bloomer"; but as there is not one word in his report† which suggests condemnation of the practice as liable to produce sugar injurious for consumption, we fail to comprehend whence the satisfaction arises. Moreover we have it on the authority of Sir Nevile Lubbock (whose letter on the subject appears on another page) that tin chloride is never used in the manufacture of *dark crystals*, and yet the yellow crystals prepared with "bloomer" only contain ·0012 per cent. more tin than do the dark ones. This therefore rather upsets the conclusions drawn by Dr. Pitsch.

But the presence of tin in food is not confined to sugar: it has been pointed out that canned meats and fruits always contain varying amounts of tin. "Thus W. Blyth found tin in 21 samples of canned fruit in amounts varying from 1·5 to 11 grains per lb. (see Pearmain and Moor's Analysis of Food and Drugs). In the United States laboratory of New York out of 109 samples of canned food examined, 97 contained tin (see Dr. Battershall's Food Adulteration)." ‡ Therefore the same reasons may be advanced in a greater degree against the use of tinned food; but we scarcely suppose that the American canning industry will thereby be induced to alter their long established system, though every now and then bad cases of poisoning occur.

So much for the baseless charge made against Demerara sugar. Reverting to the main question, is cane sugar really superior to beet? it is significant that while many claims have now and again been

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* I.S.J., Vol. V., p. 525. † I.S.J., Vol. VI., p. 292.
‡ I.S.J., Vol. V., p. 525.

made in support of cane, the beet sugar party has always had to remain on the defensive, and has contented itself with strenuous endeavours to refute or discount the evidence in favour of cane. Material facts which go to prove the superiority of beet have all along been "conspicuous by their absence." The chief one that beet is produced under cleaner surroundings cannot be any longer sustained with the advent of central factories for cane districts. In what then does the superior virtue of cane sugar exist? Chemists, whose comprehension seems incapable of soaring above the mass of formulæ with which they surround themselves, state that pure cane and pure beet are chemically identical. Perhaps they are. But there are some substances which exist, in the pure state, only in the chemists' text book. Besides, is chemical purity or identity the sole criterion? As has been pointed out lately, potato spirits and malt whiskey are chemically "identical," yet few people after sampling both would hesitate in their choice. There seems therefore something in the contention advanced that chemistry in this branch is wanting, and that there is a difference chemically which will be discovered sooner or later.

But apart from the question of chemical identity or purity, we have to consider that no sugars as placed on the market can claim to be absolutely pure, and that a cane sugar of 99% purity may possess in its remaining 1% sufficient ingredients to make all the difference in flavour as compared with a beet sugar of similar purity. This is plainly admitted by Dr. Winter, the German expert, in a patent recently brought out by him for imparting to beet sugars a flavour analogous to that possessed by colonial cane sugar. He realizes that this flavour makes all the difference in the public demand, and has taken steps accordingly to bring his native beet sugar up to the same standard. Whether he will succeed remains to be seen.

Messrs. Crosfields, Ltd., the well-known Liverpool sugar refiners, naturally anxious to ascertain wherein lies the difference between cane and beet sugar, are taking considerable trouble to solve the question. A problem recently presented itself in the form of a communication received from a leading firm of grocers in Yorkshire, who had bought beetroot sugar, and received a guarantee that it contained 99 per cent. of "cane sugar"! Whether this confusion of terms was due to ignorance or to a deliberate attempt to mislead, remained to be discovered, and Messrs. Crosfield, taking the matter in hand, called in the services of Mr. F. W. Richardson, of Bradford, a well-known consulting chemist, who appears to have made a special study of sugar and its properties. This gentleman was equal to the occasion, and his report, as sent to Messrs. Crosfield, was as follows:—

[Copy.]

F. W. Richardson, F.I.C., F.C.S.,
Member of the Society of Public Analysts, &c.,
Analytical and Consulting Chemist, and Bacteriologist,
City Analyst for Bradford,
Borough Analyst for Dewsbury, &c.

Consulting Chemist to the Bradford Corporation
(By Special Appointment).

City Analyst's Office,
Bradford,
May 19th, 1904.

Messrs. Crosfields, Limited,
6, Stanley Street,
Liverpool.

Dear Sirs,

CANE SUGAR *v.* BEET SUGAR.

Before Beets were generally known Cane Sugar was the only sweetening material used by the householder, and the chemists of the time always used the expression "Cane Sugar" as indicative of the chief constituent of the commercial article.

When a substance identical with the sweetening principle present in Sugar Cane was found to exist in other natural products, for example in the Cereals,—Barley, &c.,—the chemist still continued to use the term "Cane Sugar," though it was obviously a misnomer, and when Beet Sugar came into vogue its amount in the article itself or in the solutions made therefrom was always included under the term "Cane Sugar."

Commercial Cane and Beet Sugars contain absolutely the same sweetening principle, but this is always associated with a small proportion of other substances which communicate a peculiar and indefinable taste, mostly appreciable only to the expert Sugar merchant.

I have before me a good Cane Sugar and a good Beet Sugar, both show 99 per cent. of pure Sugar, known to the chemist as "Sucrose," but there remains one per cent. of other substances, which give distinctive tastes to these two articles. In hot liquids, such as freshly made tea for example, this peculiar and distinctive taste becomes very marked. When one considers how the merest fraction of a fraction of a per cent. of ethers in wines gives a flavour and a "bouquet," which enable the connoisseur to at once distinguish between vintages of very different values, it will readily be seen that considerably less than one per cent. of organic material in Sugars may communicate very perceptibly different tastes to the expert.

Indeed the chemical substances giving the real taste to a variety of foods and beverages are almost always present in very small quantity.

This is the case with tea, coffee, cocoa, beer, wine and spirits.

Believe me,
Yours faithfully,
F. W. RICHARDSON.

P.S.—I find myself in thorough agreement with Mr. Arthur Morris on the question of Cane *v.* Beet Sugar, and herewith return the Journal containing the Article.—F.W.R.

The reference in the postscript is to an excellent article by Mr. Arthur Morris, which appeared in *The Epicure* of March, 1899; though the whole article is eminently readable, we can give but one or two extracts.

All commercial sugars, in fact, are the chemical compound $C_{12}H_{22}O_{11}$, *plus certain commercially inseparable chemical impurities.*

The difference between Cane and Beet Sugar is thus due to two distinct causes. The more important consists in the proportion of extractives, many of which have a powerful and characteristic taste, found in the molasses, and some of these cling to the refined sugar. It is beyond the refiner's power to prevent it.

The other circumstance influencing the taste of Beet Sugar is the large amount of carbonates of potash and soda which it contains as compared with Cane Sugar. These carbonates exert indirectly a distinct effect upon the flavour of the Sugar.

That cane and beetroot sugar are practically identical seems to be the very general opinion of well informed men. There is a difference, and it is all in favour of the product of the cane. A single instance will show that it is not merely a question of prejudice. Alkaline carbonates, even in very small quantities, have a marked effect upon the flavour of many beverages which it is usual to sweeten with sugar. For example, two samples of the same blend of tea, brewed under exactly the same conditions, with the single exception that one is infused with pure water and the other with a solution of carbonate of soda in a *thousand* parts of water, give beverages differing widely in tastes and in aroma. It follows that tea sweetened with sugar containing an alkaline carbonate will not be the same beverage as that made with a sugar free from such admixture. The same effect is noticeable in coffee, and in several other sweetened drinks. Thus it is not merely the fancy of the epicure (and that is important enough) that tells him that Cane Sugar is the superior article.

Dr. Winter's admission as to the cause of the superior flavour of cane sugar is here corroborated. It is the final 1 per cent. that accounts for the difference, as far as is at present known. There is, therefore, a good deal in the contention of Messrs. Crosfields that "while it would be folly to deny that for some purposes refined beetroot sugar is possibly as suitable as cane sugar especially where merely weight, bulk, and colour are the only requisite qualities, yet at the same time it can hardly be doubted that cane sugar is superior to beet where sweetness and purity of flavour are valued, where the delicate aroma of tea and coffee may be affected, where the colour and keeping properties of preserves are an object, and where the brilliancy and cloudlessness of syrups are essential."

So far we have considered the rival merits of the two kinds of sugar from the standpoint of flavour and palatability. As to their respective nutrient powers considerably less evidence is forthcoming. A comparative test is much needed, and something of the sort seems contemplated at the Memorial Hall, Harvard University, U.S.A., where 2,000 students are boarded. It is proposed to feed them by

the month alternately on cane and beet sugar without allowing them to know which kind they are consuming. In this manner it is hoped that some definite conclusions may be drawn as to the respective sweetening and nutrient powers of the different sugars.

But whatever be the outcome of these endeavours to establish the superiority of one or other kind of sugar, it need not be assumed that the inferior variety will thereupon be driven from the market. There are too many other factors to be considered, besides those discussed in these pages. Cheapness of supply, climate of producing area, and labour conditions, all go towards settling the question. As long as the tropics find cane cultivation a standard occupation, so long will they continue to produce cane sugar. Likewise as long as beet sugar culture is profitable in temperate zones, it may be taken for granted that cane sugar will not be allowed (at least on the European continent) to usurp the position in which beet has hitherto reigned supreme for so many years. In short, there is ample room for both kinds of sugar in this world, and the particular variety most largely consumed in any given country will depend on its geographical position and on its native agricultural interests, if any.

SIR DANIEL MORRIS AND WEST INDIAN INDUSTRIES.

On the 23rd June a largely attended meeting of the West India Committee was addressed by Sir Daniel Morris (Imperial Commissioner of Agriculture for the West Indies) on "The Agricultural Industries of the West Indies." Sir Nevile Lubbock presided. Sir D. Morris' address (as reported in the *Times*) was as follows:—

Sir Daniel Morris said that there had been a general impression that most of the land in the West Indies had already been taken up for cultivation, and that very little remained for the purposes of new industries. That was quite a mistake. Allowing for swamps, rocky and other useless land, it was probable that there still remained 2,000,000 acres suitable for bearing crops of some kind. The principal crops now grown were sugar cane, cacao, coffee, fruit, limes, arrowroot, spices, and cotton. Experiments in cotton-growing had been carried on during the last three years, and the result had been to show that the West Indies could produce as good cotton as the United States. The encouragement of this industry had received special attention from the Imperial Department of Agriculture. The area planted in 1902 was 400 acres, in 1903 4,000 acres, and during the present year sufficient seed had already been supplied by the Imperial Department of Agriculture to plant 8,000 acres. There were 15 cotton ginneries already established and turning out cotton of high quality. He had arrived at the conclusion that the best variety to grow in the West Indies was sea island cotton. It was the best in the world, and it could not be grown anywhere except within the influence of sea air. Therefore, inland places like Georgia, Florida, and other parts

of the United States could not grow it. The wider interest taken in the West Indies was regarded as having begun with the appointment of the West India Royal Commission of 1896, but more particularly with the carrying out of the recommendations of that Commission under the supreme direction of Mr. Chamberlain, to whom the Colonies generally owed a large debt of gratitude. (Hear, hear.) Referring to the scientific work of the Imperial Department of Agriculture, which has its headquarters at Barbados, he said that the experiments in aid of the sugar industry were devoted to raising new varieties of canes for the purpose of increasing the yield of sugar per acre, and in obtaining canes of a disease-resisting character; also in testing the relative value of manures, and the most economical methods of cultivation, and the general treatment of cane plants. By means of the Imperial grants the experiments originally started at Barbados, British Guiana, and Antigua had been extended and improved. The area planted in new seedling canes in British Guiana had steadily increased, and now comprised about 13,000 acres. In Barbados and Antigua, owing to the occurrence of disease in the Bourbon cane, seedling and other canes were almost exclusively cultivated. The work of raising seedling canes was still, however, in the experimental stage, but it was full of promise. A factor of great importance in regard to the future of the sugar industry was the removal of the Continental sugar bounties, and every one interested in the West Indies was grateful to Sir Nevile Lubbock and those associated with him for what they had done towards getting those bounties removed. (Hear, hear.) There were hopes that the introduction of the Naudet system would lead to improved results being obtained from the sugar properties. The sugar industry was certainly in a better position than he had ever previously known it to be during the 25 years that he had been connected with the West Indies. Cacao, rice, fruit, and limes were among the most important industries next to sugar. The fruit industry of Jamaica was now worth nearly £1,000,000 per annum, and it had received a considerable impetus by the establishment of a direct line of steamships, thanks to the enterprise of Sir Alfred Jones, between that island and the United Kingdom. Having described the scheme of agricultural education in the West Indies, he said that it was out of the question that the work which the Imperial Department of Agriculture had been doing should be stopped. The way to ensure its being carried on, however, was for each colony to supplement the Imperial grants, and thereby show that they appreciated the sacrifices which the mother country was making to help them. Without a central authority in the West Indies he thought it impossible that any united action could take place with regard to any matter whatever. The time must arrive when, agriculturally, they must have, he would not say confederation, but united action. (Cheers.)

SCIENCE IN SUGAR PRODUCTION.

By T. H. P. Heriot, F.C.S.

(Continued from page 273.)

4. Manufacture.

Leaving the field, we now follow the raw material to the factory and commence our study of sugar manufacture. The operations now to be reviewed will require somewhat detailed examination although the whole process of sugar-making, from either the cane or beet, may be briefly described as consisting of five simple operations:—

(*a*) Extraction of the juice.
(*b*) Purification of the juice.
(*c*) Concentration of the juice to syrup.
(*d*) Crystallisation of the syrup.
(*e*) Separation of the crystals in the form of dry sugar.

Bearing in mind that the manufacturer's object is to obtain crystallised sugar from his raw material, whether this be cane or beet, the different methods by which this goal is reached afford an interesting and instructive example of the practical applications of science to industrial progress.

In addition to this direct comparison, we shall further inquire what progress has been made in each industry by comparing older methods and appliances with those to be seen in modern factories. Where one industry has followed the lead of the other in adopting improvements, our description of the latter must follow the same order although this will occasionally necessitate a second reference to one industry under the same section.

(*a*) Extraction of the Juice.

The Cane.

1. Milling.—Appliances for grinding the cane have been adopted from remote antiquity, so that between the pestle and mortar of the Indian native and the powerful nine-roller mills of to-day, there is a difference of efficiency but not of method.

The earliest mills were made of wood and consisted of a frame supporting two rollers, which were turned by hand. This apparatus, with a few pots and pans, completed the outfit of the Chinese sugar-boiler, who was thus able to conduct his operations in the field, moving from place to place as his services were required.

In course of time such portable mills gave birth to larger and stationary apparatus driven by wind, water, bullock-power, or steam.

It would be interesting to trace the evolution of the modern mill but we must confine our attention to a few practical aspects of the improvements made.

Efficiency.—The addition of a third roller to the primitive mill was the first step in this direction, the canes being passed between the central, and one side-roller, whilst the partially crushed cane was pressed by hand against the central roller so as to be carried round and recrushed between it and the roller on the opposite side. To avoid frequent injuries to the negroes engaged in this work a contrivance called the "dumb-returner" was invented by Bell, a planter in Barbados, at a time when vertical rollers were in general use. As first designed, this contrivance consisted of a curved wooden screen encircling the central roller at the back, the old name is frequently applied to the modern steel "trash turners."

In 1794, Collinge introduced mills with three horizontal rollers, the centres of which formed the angles of a triangle. So efficient is this combination that, although others have been tried, the three-roller mill has held its own for over a century and forms the essential feature of modern designs. Although the canes are twice subjected to pressure, such a mill is termed a single-crushing plant because the extraction of juice mainly occurs when the partially crushed cane passes through the second aperture of the mill which is much smaller than that through which the whole canes are first introduced.

Single-crushing is still extensively adopted in the West Indies, but is gradually being abandoned on the larger estates in favour of double and triple-crushing. In the latter cases we find a combination of two or more of the above three-roller mills arranged tandem, so that the crushed cane, or "megass," passes from the first to a second mill, and sometimes to a third mill, in each of which it is twice subjected to heavy pressure. The efficiency of multiple crushing is greatly increased by washing the megass with water before it enters the last mill, as mentioned below.

Strength of materials and design.—The hard wood rollers of the earlier mills were subsequently covered with curved plates of iron or steel, or were replaced by rollers of solid stone, before accurately turned cylinders of iron came into use. The frame of the mill, originally of wood, was also constructed of iron.

The steady growth of the cane industry during its more prosperous days resulted in the amalgamation of estates and the general abandonment of small mills. Engineers had then to cope with the demand for larger and more powerful mills which would grind more canes in a given time and extract a maximum weight of juice from a given weight of cane. The first requirement was obviously met by increasing the dimensions of the rollers, and the second by improved designs.

The latter mainly consisted in relieving the framework of the mill from tensional strains and causing these to be borne by wrought-iron bolts passing right through the framework. The strength of such bolts increases directly with their sectional area, and may therefore

be accurately calculated and adjusted. The recently patented "Bekker mill" is an interesting example of this design, the strains between the top roller and each of the lower rollers being respectively taken up by two sets of bolts passing through the side-frames in the direct line of the strains. The frame itself is of hollow construction and comparatively light but, as the strains fall on the bolts only, there is a great increase of strength notwithstanding the reduction in weight.

The wear and tear of the roller surfaces of a mill is very considerable, but the difference between a "hard" and "soft" roller has not yet been explained from the point of view of the composition of the metal.

Notwithstanding the superior design and strength of materials used, breakages occasionally occur; an important feature of mill-designing has therefore been to ensure accessibility of parts, enabling a broken roller to be removed and replaced without disturbing the others.

The engine and gearing have undergone corresponding improvements with a view to economising space, power, and cost. Separate engines for driving each mill of a double or triple-crushing plant are now being replaced by the more regular action of a single engine geared to two or three sets of rollers.

Self-adjustment of rollers.—The impossibility of maintaining a uniform feed of cane renders the mill liable to sudden strains which severely test the quality of the materials and workmanship. To eliminate the chance of breakdowns, two improvements have been introduced with the object of allowing the rollers to separate automatically whenever the working pressure exceeds a certain maximum. The Hydraulic Attachment effects this by means of rams forcing the bearings of the two lower rollers towards the central or top roller, but allowing a reverse motion when the working strain exceeds the pressure per square inch to which the hydraulic accumulator has been previously adjusted. The Toggle-gear was designed to effect the same object by means of levers actuated by powerful springs, but is now rarely met with.

Automatic feed.—The old-time method of thrusting the canes between the rollers by hand has long been replaced by the endless-belt conveyor which receives the cane direct from the transport vehicle, elevating and discharging same upon an inclined table from which they fall between the top and front rollers. Similar conveyors transfer the megass from the first to the second, and from the second to the third mill of a double or triple-crushing plant, and carry the residual megass to the furnaces where it is finally utilized as fuel. These various conveyors are driven by suitable gearing from the moving parts of the mill.

Whereas the whole canes are easily gripped by the first mill, the feeding of the second or third mill with the pulverised megass presents

some difficulties, this light material generally requiring to be forced between the rollers by means of long forks of wood. Here, again, manual labour has been displaced by the invention of the Riley Pusher which is adopted in modern plants.

Increased working capacity.—For a given size of roller, the quantity of canes ground in a given time increases with the apertures between the rollers. On the other hand, the extraction of juice is greatest when these apertures are small; consequently a greater quantity of work done is attended by an inferior extraction, the less perfectly crushed megass retaining too large a quantity of residual juice which is thus lost.

Beyond a certain limit, an increased speed of a single-crushing mill also results in a loss of juice, even when the apertures between the rollers have been properly adjusted. In this case the loss is due to the fact that the expressed juice has not time to freely escape from the surface of the roller before it is partially re-absorbed by contact with the megass; loss from re-absorption is greatly reduced by double or triple-crushing.

This two-fold demand for quantity and quality in milling has consequently been sought for in a preliminary disintegration of the cane before it enters the mill. The Ross Cutter subdivides the cane into shavings which form a more compact feed to the mill, but are not so easily gripped, as the whole canes. The more general plan is to pass the cane through a crusher or shredder, which are modified mills having rollers with V shaped grooves as in the "Bekker Crusher," zig-zag corrugations as in the "Krajewski Crusher," or projecting teeth as in "Faure's Defibreur." These several inventions aim at reducing the cane to a shredded mass which will more readily part with its juice under the pressure exerted by the subsequent milling.

Any approach to a perfect extraction by milling is both theoretically and practically impossible, and the residual megass when sent to the furnaces always contains an appreciable quantity of juice. To reduce this to a minimum, a process of dilution, termed maceration, is now generally adopted in conjunction with multiple-crushing, which consists in spraying the megass with hot water as it leaves the first mill of a double crushing plant. This water, coming in contact with megass immediately after its compression, is readily absorbed by the expanding material, and dilutes the residual juice which has escaped extraction by the mill. When the moistened megass enters the second mill a large proportion of the diluted juice is extracted, whilst the moisture left in the re-crushed megass consists largely of the water added for maceration. This process therefore recovers more juice from the cane but, at the same time dilutes it and necessitates additional evaporation at a subsequent stage.

In the case of triple-crushing, advantage is taken of the fact that a richer juice is extracted by the first mill than that obtained by

re-crushing the megass; consequently, the juice expressed by the third mill, being of a distinctly lower density than the first mill-juice, may be used for macerating the megass leaving that mill. The megass from the second mill may then be macerated again with water, as in the double crushing process.

We may therefore note that the method of extraction by milling has been brought to a high degree of perfection, the unavoidable losses being reduced to the lowest limits. Other methods of extraction have been borrowed from the rival industry and will be referred to after their original applications have been described.

The Beet.

The pioneers of this industry naturally turned to their cane rivals for instruction in the methods of sugar manufacture, and we shall first briefly describe the earliest method of extraction adopted.

1. Rasping and Pressing.—In the beetroot, as in the stem of the cane, the saccharine juice is enclosed in minute cells which must be broken before the contained juice can be liberated by pressure. These two objects are effected simultaneously by milling the cane, because the resistance offered by the hard external portions of the stem confines the pressure to the softer cellular structure which is thus destroyed, the liberated juice escaping whilst the solid fibre is under compression. The softer material of the beetroot offers little resistance to compression, so that the microscopic juice-cells pass uninjured through a mill, and no free juice is extracted.

The destruction of the cellular structure was effected by reducing the roots to a pulp. Two types of rasping machines were devised for this purpose, one adopting a cylinder with external teeth against which the roots were pressed automatically; the other, a revolving drum, into which the roots were fed and thrown by centrifugal force against an internal cutting surface, formed by alternate rows of saw-blades with intermediate apertures, through which the finely divided pulp escaped into a receiver. These rasping cylinders were driven at a high speed, and reduced to pulp some 60,000 to 100,000 kilos of roots in 24 hours. Water was added during the operation, and the mixture of pulp and water transferred to small sacks ready for pressing.

This second operation was originally effected in two stages, an automatic screw-press extracting about half of the contained liquid, and powerful hydraulic presses completing the extraction. The process was wasteful and required much manual labour, so that other methods of pressing were eagerly sought for.

In 1836, Pecquer attempted to utilize the method of milling as employed in the rival industry, but without success, and it was not until 1865 that Poizot's continuous press made its appearance. This apparatus took the form of a mill having two large and six small rollers. The mixture of beet-pulp and water was fed into a

hopper, whence it was distributed upon an endless belt of woollen cloth passing between the rollers and carried forward by their motion. The six small rollers were mounted around the circumference of the first large roller, in such a manner that the pulp was subjected to a gradually increasing pressure in passing through the series. The expressed juice was forced through the woollen cloth and collected in a receiver below, the pressed pulp being carried forward by the belt, and removed therefrom by a mechanical scraper.

This apparatus was a great advance on the hydraulic presses, and the extraction was further increased by passing the pulp through two such presses in succession (a method subsequently adopted for double-crushing of the cane).

This principle was improved upon in the continuous press of Manuel and Socin, by sprinkling the pulp with hot water during its forward motion through five pairs of rollers arranged in line. A further modification, introduced by Champannois, utilised the external area of hollow rollers as filtering surfaces, and thus dispensed with the endless-belt of cloth. His design was further modified in the presses of Collette, Lebeé, and Dujardin.

Many other designs of great ingenuity appeared, but they all had a common defect, for the finely pulped root escaped through the filtering surfaces and contaminated the extracted juice. The latter had therefore to be re-filtered before the next process could be proceeded with.

2. Diffusion.—The foregoing method of extraction and the various improvements effected in the machinery are now only of historical interest. Not satisfied with a method which extracted more juice from the beet than their rivals in the tropics could obtain from the cane, the beet sugar fabricants sought for something better. In 1830, Dombasle proposed slicing the beet into thin shavings, and macerating these with hot water in a series of vessels, but the juice so obtained could not be successfully purified by the methods then adopted for juices extracted by pressure. When these purifying methods were improved some thirty years later, Robert, an Austrian fabricant, again brought forward the maceration process of Dombasle, and, improving on the latter's original apparatus, finally established the diffusion process which has since been adopted in every sucrerie. The principle of this method is based on the well known tendency of dissimilar liquids to intermix or diffuse into each other, due to an attractive force existing between their component particles, or molecules. The same tendency is observed in the diffusion of solid substances when brought into a state of solution; thus, a lump of sugar, dropped into a glass of water dissolves, because the attraction between the individual molecules of sugar is weaker than that between the molecules of sugar and of water. If the glass is left undisturbed, the melting of the sugar results in the formation of a dense layer of

syrup, which remains for some time at the bottom of the glass. But, very gradually, the syrup diffuses upwards into the water, and the latter passes downwards into the syrup, the two liquids continuing to move in contrary directions until the entire contents of the glass are of uniform composition.

From the above instance of simple diffusion we pass to a more complicated case in which the syrup and water are no longer in immediate contact but are separated by a thin membrane, such as a piece of ox-bladder, or parchment paper. Under these conditions diffusion again takes place, the two liquids passing through the membrane in contrary directions and freely intermixing on either side of it until equilibrium is established.

Such a membrane is not sufficiently porous to act as a filter and may even be described as water-tight, but, when wetted on both sides, it behaves as though it were highly porous to certain liquids, and it has been experimentally proved that the rate of diffusion of different solutions is intimately connected with the property, of the dissolved substances, of assuming the crystalline form. Thus, sugar and many salts which readily crystallise are also easily diffused through a membrane, whereas such substances as gum, albumen, &c., which cannot be crystallised are practically non-diffusible.

Membrane-diffusion, also called osmosis or dialysis, therefore affords a ready means of separating certain substances, and has long been recognised as playing an important part in numerous physiological processes. Dombasle's application of this principle to the problem of extracting sugar from the beet resulted further in the separation of the sugar from admixture with certain un-crystallisable impurities dissolved in the natural beet-juice. This interesting example of applied science may be conveniently illustrated by describing three simple experiments, in which a single microscopic juice-cell of the beet is roughly represented, on an enlarged scale, by an ox-bladder.

Experiment 1.—The bladder is filled with sugar-syrup, securely closed, and immersed in a pail of water. An outward diffusion of syrup and an inward diffusion of water then takes place through the animal-membrane. After a sufficient lapse of time, no difference can be detected between the contents of the bladder and the surrounding liquid, either by the taste or by means of chemical tests. The bladder, now containing a dilute solution of sugar, is re-closed and immersed in a second pail of water, when an interchange of liquids through the membrane re-commences and continues until equilibrium is again established. Obviously, the bladder may be thus repeatedly immersed in fresh portions of water until the last traces of the original syrup have diffused away and been replaced by fresh water.

Experiment 2.—The bladder is now emptied and re-filled with a solution of a non-crystallisable substance, albumen or white of egg. After repeating the former operations, it will be found that the

albumen remains undiluted in the bladder and can scarcely be detected in the immersion waters by the most sensitive chemical tests.

Experiment 3.—Finally, the bladder is again filled with syrup and a little albumen added to represent the natural impurities existing in the beet-juice. The preceding operations are then once more gone through, the sugar escaping from the bladder by diffusion whilst the albumen remains behind. On evaporating the water from the numerous pails employed, we may easily recover the whole of the sugar in the form of a pure syrup. The bladder, which represents the beet-cell deprived of saccharine juice, and which also contains the separated impurity (albumen) may now be thrown away or otherwise utilised.

Such being the scientific principles upon which beet-diffusion is based, we need only outline their practical application.

The slicing-machine reduces the whole roots to very thin sections or shreds of large surface-area. Although thus finely divided, each shred must necessarily consist of a vast number of juice-cells which cannot be further separated; diffusion is therefore retarded, and the practical extraction of the juice, although very satisfactory, is never complete.

The diffusion apparatus comprises some 12 or 14 vertical cylinders, called diffusers, generally arranged in the form of a circle, and which are filled in turn with the beet-shreds as they gravitate from the slicing-machine. When thus filled with the loose material there remains considerable vacant space due to the numerous interstices between the shreds. This space is subsequently occupied by liquids which are thus brought into intimate contact with the shredded material. Diffusion then takes place through the cell-walls which form separating membranes between the beet-juice on one side and the diffusion liquid on the other.

In contrast to the experiments with the bladder, the shreds are not transferred from one diffuser to another, the same result being more simply effected by moving the diffusion liquid. For this purpose the bottom of each diffuser communicates with the top of the adjacent vessel by means of a short curved pipe, in such a manner that any number of diffusers may be connected to form a series through which the diffusion liquids may be moved forward in one direction only.

When the work is in progress, a large number of vessels are thus connected in series, each being completely filled with liquid in contact with the beet-shreds. Water being forced into the first of the series of diffusers causes a simultaneous displacement of liquids in all the other vessels, the liquid in each being driven forward into the following vessel through the connecting pipe. From the last diffuser of the series a corresponding volume of liquid overflows and escapes from the battery by a suitable outlet pipe. During this forward motion of liquids the beet-shreds remain stationary in each vessel and, although

always immersed in liquid, that liquid is constantly being changed or renewed.

At one end of the connected series we find the diffuser which has been just filled with fresh beet-shreds, and which contains a liquid very rich in sugar (diffusion juice). The diffuser at the other extremity of the series contains shreds from which the sugar has been extracted by many changes of liquid, and is now filled with fresh water. The contents of all the intermediate vessels vary progressively between these two extremes as regards saccharine richness.

The main feature of the work consists, therefore, in submitting the beet-shreds to a graduated extraction produced in each diffuser by the repeated displacement of liquids, containing more or less extracted sugar, by other and more dilute liquids.

Fresh water is forced into every diffuser in turn as a final washing and is driven forward into the following vessel by means of compressed air before the spent beet-shreds are discharged through a large door, which forms the bottom of the vessel.

Each diffuser, thus emptied, is disconnected from the battery-circuit or series, re-charged with fresh material falling from the slicing machine, and re-connected at the other extremity of the series. In other words, diffuser No. 1, after emptying and re-charging, becomes No. 12, and what was formerly No. 2 now becomes No. 1.

The foregoing sequence of operations are performed with an almost automatic regularity by the battery men, who, moving from one diffuser to another round the circuit, repeat a routine of simple operations, charging this vessel with fresh beet-shreds, emptying the spent material from that, adding water here, and withdrawing diffusion juice there.

Full particulars of the construction and manipulation of the diffusion battery may be found in numerous technical works dealing with the subject.

One of the latest improvements is the Naudet system of diffusion by means of forced circulation. This is a mechanical modification, which ensures a more rapid and perfect extraction of juice from the terminal diffuser containing fresh beet-shreds, and which has led to a considerable reduction in the number of vessels forming the battery. The diffusion juices are purer and in every way superior to those obtained by the ordinary battery.

The Cane (continued).

2. Diffusion of Sliced Cane.—The application of diffusion to the cane appears to have originated in the French colonies as far back as 1843, when unsuccessful attempts were made to ship the dried cane slices to Europe for the extraction of the sugar by the diffusion process as there applied to the beet. In 1845 Constable and

Michel diffused the sliced cane on a sugar estate in Guadeloupe, but the results were disappointing, owing to the primitive apparatus they employed. Their experiments were continued two years later by Davier, whose improved diffusion process for cane was approved by the French Government, which commissioned him to erect a large battery on the King's estate in Martinique, but this scheme was abandoned. Bouscaren, in Guadeloupe, placed the process on a more practical footing in 1876, and it was worked most successfully for many years.

Robert's process of beet-diffusion was successfully applied to the cane at the Aska Works, Madras, and subsequently introduced into the British West Indies by Mr. Quintin Hogg.

Regarded as a method of extraction, the diffusion of cane has proved quite as effective as with the beet, and many persevering efforts have been made to secure the advantages this process offers over extraction by the mill. But these advantages are always attended by a heavy fuel account because the spent cane-slices can only be partially dried by being passed through a mill and are thus reduced to a powdery condition of inferior fuel value.

Since the introduction of powerful multiple mills, the advantages of cane-diffusion have largely disappeared, and, taking the fuel problem into consideration, the diffusion process no longer shows a financial profit, and has been generally abandoned.

3. Maceration of Megass in the Diffusion Battery.—The diffusion battery has been further utilized, as a supplement to the cane mill, for recovering that portion of juice which is generally lost in the crushed fibre or megass. Experiments in this direction were first made in 1876, at Torre del Mar, Spain, which led to the successful adoption of "megass-diffusion" in that factory in 1885. The spent megass was used as a manure, no attempt being made to dry it so as to render it fit for fuel. This process had no material advantage over the direct diffusion of the sliced cane and has not been heard of for many years; we mention it because it foreshadowed a novel method of extraction which is now coming to the front.

The cane industry is indebted to M. Naudet, the well-known beet-sugar expert, for his diffusion battery as first applied to the beet industry, and also to Messrs. Hinton & Sons, of Madeira, for their enterprise and energy in adapting the battery work to the problem of extracting sugar from crushed cane. Their assistance and co-operation has enabled the inventor to evolve a most interesting and highly efficient process, a description of which appeared in the April issue of this Journal. We need here only state that the Naudet Patent Process, as first applied to the cane in 1902, closely resembles the treatment of megass in Spain in 1885, but utilises the spent megass as fuel. This system has been adopted with great success in Egypt

where it is extending. The Naudet process, as modified at Messrs. Hinton's factory, greatly facilitates the subsequent treatment of the juice, and will be again referred to.

We conclude this paper with a table indicating the comparative efficiency of some of the methods of extraction referred to. The figures represent the sugar extracted from 100 parts of sugar contained in the raw materials.

CANE.		BEET.	
Single crushing	74	Hydraulic pressing ..	93
Double crushing	83	Poizot's double press..	95
Double crushing, 12% dilution	88		
Triple crushing, 10% dilution	90-92		
Diffusion, 25%, dilution	94	Diffusion	96-97
Naudet process, 15% dilution	94-95		

(To be continued.)

POLICY AND ADMINISTRATION OF CENTRAL MILLS IN QUEENSLAND.

The "Sugar Works Guarantee Act of 1893" is termed "An Act to authorise the making of Advances by way of guaranteed Loans, for the establishment of Sugar Works, and to provide for the repayment thereof, and for other purposes connected therewith."

In addition to the definition given, it is indicated by the test of the Act that its original purpose lay in granting permission to Incorporated Companies to obtain money for purposes set forth. Section 4 of the Act of 1893 states "subject to the provisions of this Act, it shall be lawful for any company to apply to the Treasurer for permission to issue debentures for the purpose of defraying the cost of Sugar Works and of the erection of the same, and the Treasurer may grant such permission." Section 7, of the same "Principal Act," continues "Upon such permission being granted, it shall be lawful for the Company to issue, and they are empowered to issue debentures under their common seal, payable to the bearer. . . ." It is in section 9, of the Principal Act that the position of the Government under its operation is first indicated. "It shall be lawful for the Governor-in-Council to guarantee to the holders of such debentures the due payment of principal and interest; and thereupon such payment shall be a charge upon, and shall be made good out of the consolidated revenue, which is hereby permanently appropriated for that purpose."

It is made to appear, by Section 9, of the Principal Act, that the office of the Government was intended to be limited to encouraging the Public to purchase the debentures of a Company which the Treasury would guarantee. "Reasons of State" made it advisable that Parliament should proceed beyond the condition of guarantee by the Treasury, therefore Section 2 of the "Act 1895, to Amend" the "Sugar Works Guarantee Act of 1883" states that "Notwithstanding the provisions of the Principal Act, the Governor may, by warrant under his hand addressed to the Treasurer, empower him to purchase out of money appropriated by Parliament for the purpose, the amount of any debentures heretofore or hereafter to be issued by such Company under the provisions of the Principal Act." By virtue of that Amendment, the Government of Queensland became a partner with Central Mill Companies in the sugar business; and by the same instrument those Companies obtained access to the Public Moneys through the Treasury.

Having offered the public funds for the use of the Companies, Section 11 of the Principal Act provided that "For the purpose of securing the consolidated revenue against loss in respect of such guarantee, the Company shall execute in the name of, and to the satisfaction of the Treasurer, a first mortgage over the Sugar Works, and over such additional freehold land to be used for the purpose of cane growing. . . . ."

In further protection of the Treasury, Section 16 provides that "If any default be made by the Company in payment of any portion of the principal or interest, the price of cane to be purchased shall be fixed by the Treasurer." And finally, in Section 17, it is provided that "If any default whatsoever be made by the Company it shall be lawful for the Treasurer to enter into possession of such sugar works. and of all land mortgaged to him, and to manage and conduct the same, and to appoint all necessary managers and servants, until the whole liability resting upon the consolidated revenue has been fully discharged, or to sell the same by public auction if he thinks fit."

The lands that have been brought under sugar cultivation by the establishment of central mills had previously, and for other uses, a relatively small value. The aim, in placing the mills upon those lands in given localities was to raise their value for sale, and for producing purposes.

The specific value put upon those lands by "a valuer appointed by the Treasurer" was dependent upon their use for sugar growing, and contingent upon a mill being located upon them.

The value of "a first mortgage over a sugar works" as a security is contingent upon the power of a plant to earn where it is located. If a mill fails to obtain cane, or to manufacture sugar at a profit or ceases to operate, its worth as a security depreciates enormously and at once; and the land around it drops to its original and nominal value.

The only actual and certain security for the State Treasury, and for the shareholders in the undertaking, lay in providing the conditions necessary to make the business of a Central Mill Company a success, and the provisions of the "Sugar Works Guarantee Act" have not afforded protection in that respect.

The applications in which are "set forth the land upon which it is intended to grow cane" include areas unsuited to cane culture, and which, it is stated on authority, "were thrown in to make up the amount of security." Moreover, neither the Act, nor the Regulations under the Act, contain any provision for enforcing the growing of "a sufficient quantity of cane for keeping the sugar works employed."

The Act, in requiring "that sufficient land to keep such a sugar works so employed, and of a quality to produce adequate crops of cane" has omitted wholly to provide that central mills shall be placed in such localities only where an average of rainfall is assured, by the records of previous years, to co-operate with "land of an adequate" quality to produce cane crops. It has already been shown that the main cause of the failure in earning power of four of the five mills that have been under special investigation was "shortage of crop, due to small rainfall." All of these mills have been established since the Government entered conjointly into the business of sugar production.

In the actual business of the growing and manufacturing of sugar, and in the direction of a central mill's affairs, no provision is made by the Act whereby the Government, as a partner, shall join in the control until such time as a "default be made by the Company, when the price of cane shall be fixed by the Treasurer, or it shall be lawful for the Treasurer to take into possession of the Sugar Works and conduct the same," or after foreclosure, "to sell the same by public auction."

The Act, as it stands, merely provides that the Treasury may hand over the public moneys to a central mill to be engaged in the business of sugar making, to be under the control of a directorate selected from the members of the Company, and without the co-operation, aid, or restraint of the Government, which to all intents is a partner in the business, and is moreover solely responsible for the public capital that has become engaged in the business.

The directorates of central mills were appointed by, and from the members of a Company, and, in the nature of the situation, were most generally men who had no knowledge of the business of sugar manufacture, nor experience in the control of large undertakings. The shareholders, or members of a Company, comprised, in the main, cane farmers, men of small means, whose experience had related to business on a domestic scale, and who could not be esteemed responsible for any idea or knowledge of technical concerns, notwithstanding the general honorableness of their intentions, and competence within the limits of their business as farmers. It must be understood that it

was not necessarily any defect on their part that those men assumed the direction of technical and commercial undertakings out of their experience and competence. That was the due result of the provisions of the Act. Can it be conceived, however, that a great private Company of manufacturers would select four or five from the number of its cane farmers and hand over the direction, and the technical and financial management of the mill business to those men? But that is what was done by the Queensland Government, under authority of the Act. And it may be stated that the extreme results of such a policy and action were only averted by the circumstances that advice and aid were obtainable from the officers of private sugar mills that were operating in the same localities.

From the character and lack of appreciation of their corporate responsibilities, disadvantage and loss have resulted direct from the actions of several directorates. The first necessity of united action has not been understood, and boards of directors have been dissolved into factions, and these factions have followed opposite courses and conflicting aims. In given cases these troubles within the directorates have extended to the staffs of the Company, resulting in some officers supporting, or being supported by one faction, and others by another faction of the body of directors. Such a situation again suggests the inquiry as to what would be the business end of a private firm if its heads were leading opposing camps composed of the clerks and assistants of the house, and they were devising and working along conflicting lines? At this time, correspondence dealing with three instances of directors in conflict is under consideration by the Government, and in two of these cases officers of the respective Companies are involved. These matters are the direct outcome of the operation of the Act, and of the absence of provision for responsible action by the Government, who is the chief partner, and the chief loser in these affairs.

It has to be said that some improvement has been made since the time of their establishment in the management of central mills; yet, due to rotation in the directorate, and to a lack of primary knowledge of incoming directors, and their inability to examine and select competent managers, and to co-operate with them, the work in the mills is still far below what it should be. Noting this, the Director of the Sugar Bureau appointed a chemical inspector to make detailed examinations of the mode of operation and actual control of the mills, and to report to him upon the present actual state of things. The reports of the inspector cover the past crushing season, and they show that the *aggregate of preventible losses* in eight central mills, not including four of those that have come under special consideration in this report, during the recent year amount to £13,500, which are due to defects in management and control.

The foregoing considerations have shown that in order to get the

central mills established the Parliament had to authorize the Government to buy up their debentures and advance the necessary moneys. As security for the loans, the Treasury accepted mortgages covering the mills, and also land intended for growing cane. Actual security, however, lay solely in making the mills pay, and this depended in the first place upon the fitness of their location, and afterwards upon the management and control. Those examples of mills that have been considered indicate that the selection of their local ties, due to weather conditions, was an error, while the direction of the central mills in general has been inexperienced and incompetent and the management technically crude. In brief, by authority of the Sugar Works Guarantee Act, the Queensland Government entered as a partner with the Central Mill Companies into the sugar business, and without providing the common business assurances of safety and success for the companies or for itself. As a result, and by provision of the Act, the security of the Treasury is made to rely solely in foreclosure and in seizure of the land of the shareholders, which it should be the policy and the first purpose of the Government to avert.

To furnish actual security for the public moneys advanced by the Treasury, and to protect shareholders against loss of their lands, it has to be advised that the Government shall assume a full responsibility of its relations with the Central Mill Companies, and enter into an active co-operation in the control and management of those mills whose financial state demands intervention.

The Government Central Mills vary between wide extremes in their present financial state, and for such reason it is advised that they shall be resolved into three several classes and the measure of intervention of the State determined by the financial condition of each class.

A. Central Mills which have maintained their business in a sound condition, and have met all obligations to the Treasury up to the present date. There is no ground for intervention in the affairs of mills of this class; and the Government should confine itself to affording any advice or aid which their directors may solicit.

B. Central Mills whose business is not in a progressive or sound state, and that are in arrears of obligation to the Treasury, and relating to which the present Sugar Works Guarantee Act provides that the Treasury may intervene. Some extreme examples of mills within this class have been considered. It is advised that all mills that are in present arrears of payment to the Treasury, and any mill that may come into arrear, shall be included within this class. It is further advised that in the direction of the affairs of each mill of this class the Government shall co-operate, and shall aid in the management and control of its business. This co-operation and aid

shall be in such as the matters that have been set forth in the case of the Gin Gin Central Mill and others, and which are here recapitulated:—

1. That the Directorate of the Company, conjointly with the Government, shall adopt and execute measures guaranteeing, so far as natural conditions allow, an adequate supply of cane for the mill.
2. That the technical management of the mill shall be supervised by an officer of the Sugar Department of the Government.
3. That no extensions or additions to the mill or rolling stock shall be made without the concurrence of the Government.
4. That the price of cane each year shall be fixed by, or in concurrence with the Treasurer, as required by Section 16 of the Sugar Works Guarantee Act.
5. That no tender of price for sugars shall be accepted without the concurrence of the Government.
6. That no loan shall be contracted with any outside party, involving a lien upon the crop or otherwise, without the concurrence of the Government.

In respect of Article 6, it is advised that the Government shall uniformly finance central mills, in their temporary requirements, in order that the companies and shareholders may be financially aided at the lowest rate of interest, and that outside parties shall not intervene where the Government has a concern.

In dealing with arrears of interest and redemption of a central mill it is advised that, after the Treasury has allowed a fair price for cane, which shall depend upon the quality of the cane and the ruling price of sugar, and after the costs of running and maintenance have been met, any balance of the profits shall be paid to the Treasury in liquidation of the Company's obligations. If it is deemed advisable to determine upon a fixed sum to be paid by a Company annually, then a reserve fund should be established into which any balance shall go after meeting the fixed annual repayment in a good year, as provision for such payment in bad years. Years may occur when no repayment can be made and years when the profits may allow of double the amount of the fixed sum being paid. The reserve fund will equalize these conditions.

C. Central Mills that have not met any portion of their obligations to the Treasury, and whose present conditions are unsound and without assurance; or where the Directorate has not conducted the business honorably, in view of its obligations to the State Treasury. It has to be advised that any central mill which falls within this class shall be taken over from the company by the Treasurer, and its affairs controlled in the interest of the Treasury, and of others concerned.

In entering into active co-operation with the directorates in the control of central mills, it will require to be pre-eminently understood

that it is strictly as a business factor that the State engaged in the undertaking. That this understanding shall be effective, and the action of the Government strictly the course of action of a business partner, and unhampered by non-business influences, and by the delays incident to common administrative methods, a separate and distinct Bureau will require to have charge of the business, and of all intercourse and transactions between the Government and the Central Mill Companies.

As the production and manufacture of sugar is a highly technical business, such a Bureau will require to be in charge of a person of high technical and practical knowledge, and of administrative capacity, who may be known as the Controller of Central Sugar Mills. The technical officers, and also the clerical staff of the Bureau, shall act under the Controller's instructions in all outside work and investigations, and in matters of the office, in order that the administration may be systematic and precise, and that matters may receive prompt and exact attention, as in an ordinary and private business.

Because of the specific and technical nature of the sugar business, which distinguishes it from general agriculture, and in view of the inconvenience and delay which follow upon the administration of the Sugar Works Guarantee Act by two Departments of State, as at the present time, it appears most advisable that the proposed Bureau of Central Sugar Mills shall be solely under administration by the Treasury, whose Minister is the Mortgagee, and the lawful representative of the State in its transactions with the central mills. Under such arrangement the Controller of the Bureau will act as technical and business adviser to the Treasurer, and administrative course between the Treasury and the Central Mill Companies.

As it may be required to amend the Sugar Works Guarantee Act to enable given recommendations of change to be put in operation, it is expressly urged that the practical aspect of the State's relation with the central mills shall prevail. That relation is a business one, for a business end, and it should be provided to maintain and conduct its operations on strictly business lines.—*(Mackay Sugar Journal.)*

Heavy rains in Cuba brought the harvesting to a standstill at the end of May, and the estimate of the total crop is now about 1,000,000 tons. 118 centrals are at work this year as compared with 90 last year and 23 in 1902.

The manufacture of molascuit is steadily increasing. The Chaparra Sugar Co., Cuba, has just built a factory for turning out this cattle food, and should the venture prove successful, it will doubtless be extended to other factories in the island.

THE SUGAR INDUSTRY IN JAVA.

By H. C. Prinsen Geerligs,

Pekalongan, Java.

(Continued from page 285.)

After the cane has had its last banking, usually in December or January, the skill of the planter comes to an end and the only thing that he has to do is to leave the cane to take its chance. The rainy season is then in full swing; the manure works intensively, promoting the growth of the young plants, which increase both in length and in thickness. At the end of the growing period a small leaflet appears at the top of the cane, soon followed by the beautiful bunch of flowers which ends the vegetation of the plant. Before that time, however, whirlwinds have knocked down the canes on many a spot; the latter raise themselves again to some extent, but the field soon becomes an intricate mass of fallen canes, in which one can no longer find a path.

As soon as the cane is ripe and the roads dry and hard (the rainy season having passed) the grinding time commences. An auspicious day is selected with the assistance of some native astrologer, or a similar worthy, and the grinding inaugurated with a feast of more or less importance. The native coolies, working at the factory, are entertained and feast on the masses of eatables and dainties put at their disposal, and afterwards witness native sports, performances of bayaderes, &c. The European guests gather round the mills, which to keep off ill-luck are adorned with the heads of the goats and bullocks slaughtered for the dinner, drink a glass of champagne to the success of the millowner, and put a few canes between the rollers of the mill as a token of their willingness to help if their assistance is required. After this feast a few days of rest follow and then the grinding time begins in earnest. This is the busiest time of the year; day and night, Sundays included, the mills work, yielding a continuous stream of cane juice, which is immediately turned into commercial sugar by the factory plant.

Great care must be taken to ensure a regular supply of cane in order to keep the mill going; on the other hand one must be careful not to cut more cane at one time than the mill can crush, as cut canes very rapidly deteriorate in this hot climate. It is clear that this question is already a weighty one at ordinary times and becomes more intricate when a field is burnt by accident or out of mischief and requires immediate cutting. Sometimes the transport of the cane is hampered by the foot and mouth disease, or by *surrah*, or the roads are soaked with heavy rains, preventing the bullock carts from traversing them with their load of cane, which all goes to make the supply of cane rather difficult to get.

We always try to cut the cane at its highest degree of ripeness, to which end the cane of the various fields is regularly analysed, starting as early as February. Samples are taken every fortnight from every field and analysed at the factory laboratory; if the analysis shows that the sugar content is not rising any more, the cane is considered to be ripe and wants cutting. It is clear that in many cases other circumstances may occur which may interfere with the regular cutting of what happen to be the ripest canes; for instance an immature field burns down and of course wants immediate cutting, thus leaving an already ripe field exposed to the danger of becoming overripe, by its standing too long in the field; but anyhow the steady sampling and analysing of the canes before and during grinding has contributed much to increasing the yield of sugar per acre in Java.

As is observed above, the grinding time is a most busy period, not only the standing crop has to be harvested, transported and worked up without delay, but the cutting of the old crop coincides with the planting of the new one, so that all the work connected with the digging of the rows, the transport of tops, of manure, the care of the irrigation water, &c., has to be provided for. The work goes on steadily day and night, the manager and his overseers are all day in the field or the factory till late in the evening; and a council is held every night to report on the work of the day past and to prepare that of the morrow. It is a nervous time, Sundays or holidays are unheard of and nothing is neglected that might conduce to finishing off the crop as rapidly as possible; only from six to seven o'clock in the morning is the work in the factory suspended, and then only for the purpose of cleaning the mills and measuring tanks, otherwise no rest is given, if we can possibly avoid it.

The coolies undertake the cutting of the cane; owing to the repeated bankings the canes are 1 or 1½ feet under the surface and it is necessary to reap the undermost piece too. The canes are therefore dug out from the land and cut off as low as possible; of course this can be easily done since we do not keep ratoons here and are free to reap all of the cane and leave nothing behind. Then the top with the green leaves is cut off and used by the natives as cattle food, they being allowed to take it free of charge. The canes are carried to the factory with the least possible delay; formerly all of the cane was transported in bullock or buffalo carts, but this old method has proved too slow now the planted area is extended, and is gradually being superseded by rail transport using either cattle or steam for traction.

The cane is crushed at once as soon as it reaches the mill. Most estates are equipped with treble crushing, preceded by a preliminary treatment of the cane by means of shredders, cane cutters or crushers, and followed by maceration, sometimes with water, and sometimes with water and the last mill's juice. In the latter case the bagasse from the first mill is macerated with the whole of the juice extracted

by the last mill, while the bagasse from the second mill is macerated with water and passed through the last mill of which the diluted juice is, as has been said, used for macerating the bagasse between the first and second mills. The green bagasse is used as fuel without being dried beforehand. The diffusion process is entirely wanting in Java ; it is rather probable that one or other of the many systems in trial now for macerating or exhausting the bagasse will come into use, but as yet milling work is universal.

The extracted juice is limed, either using a small quantity of lime which remains in the juice (defecation) or else we use a large amount of lime cream and remove its excess, after the action of the lime is completed (carbonatation). The clarified juice is filtered or allowed to subside, evaporated in vacuo, settled again and boiled into masse-cuite in the vacuum pan. Formerly a second boiling was made from the molasses, but now this is only the case if white sugar is manufactured; in the manufacture of the principal product, viz., refining crystals, the first molasses are returned into the vacuum pan in order to obtain all the available sugar from the juice in one product and in one operation. Most factories still obtain the so-called black stroop or tank bottoms, a low grade kind of sugar, from the last molasses, while other factories immediately divide their masse-cuite into commercial sugar and exhausted molasses, which latter is thrown away as worthless.

The sugar is dried in revolving drums, heated by steam or by hot air, packed in bamboo baskets, lined with mats, containing 700 pounds and shipped.

During the whole process of manufacture the chemists of the factory sample and analyse the cane, bagasse, juices, syrups, &c.; such chemical control in the factory is universal in the Java sugar-houses, and enables us to obtain trustworthy average figures.

The sugar cane in Java contains on an average 13-14% sucrose, of which about 90% is extracted in the juice and the remaining 10% is burnt in the bagasse. The quantity of commercial sugar obtained from the amount of sucrose depends chiefly on the purity of the juice and next on the kind of sugar made, as more sugar gets lost when turning out white sugar than when refining crystals are made. As a rule the losses in molasses may be put down at 10%; then we have still further to record the loss in filter press cakes and unaccounted for, so that we may take the total loss at 20 or 22% of the sucrose in the cane. These are big figures, and it would be worth our while if anything could be found to reduce them. The sugar lost in bagasse diminishes every year by the improvements brought about in the milling process, and if one of the systems of desaccharifying the bagasse were crowned with success, half of the loss would at once be recovered. The other half, that in the molasses, is not so easily obviated. What can we do with it? We could make rum or alcohol, but the market for these products is so restricted that it would not

pay. The natives are not to be induced to spend money in buying molasses for their cattle, so the only thing left is to burn it in the furnaces or throw it away into the river. The other losses are insignificant, and though it is a common saying in Europe that in the tropics the work is done in a rather careless manner, we do not deserve such a reproach in Java, as everything which science or experience can suggest to us as advantageous for our industry is investigated and tried, as well in the field as in the factories, and in the laboratories of the experimental stations supported by subscriptions from the sugar estates.

Java has 182 sugar estates with the following area :—

	Per cent.	Bouws.	Hectares.	Acres.
1898.	100	113,207	80,337	198,500
1899.	104	117,632	83,477	206,440
1900.	113	127,916	90,775	224,100
1901.	127	143,849	101,694	242,100
1902.	129	145,463	102,835	256,000
1903.	128	145,154	102,510	249,000
1904.	130	146,402	103,894	259,000

The considerable extension of the area under cane in the years between 1899 and 1901 is due to an Ordinance, issued by the Government, fixing the area of every estate at the existing surface under cane in maximo, with a view to reserving sufficient land for the rice cultivation of the natives. This maximum may not be exceeded without special permission of the Governor General; as however a term of three years was allowed before the Ordinance came into force, the millowners made use of that delay to plant as much land as possible and thus increase their legal maximum. After that period the extension has came to a standstill, which is clearly shown in the figures given above, and now we may consider the further extension of the Java sugar industry as practically insignificant; the only increase, we can expect, would be due to an extension of the irrigation system, which might open up new districts for the rice and cane cultivation, or to still more indigo factories, ruined by the competition of the artificial German indigo, turning over their land into sugar cane fields.

The tonnage of cane and sugar has been as follows in the last years.

	Cane.		Sugar.		
	Tons.	Cwts.	Tons.	Cwts.	Per cent.
1894	26	17	2	16	10·36
1895	30	5	2	19	9·79
1896	27	0	2	17	10·55
1897	28	18	3	2	10·06
1898	34	12	3	11	10·21
1899	32	9	3	11	10·94
1900	33	10	3	4	9·57
1901	30	5	3	2	10·16
1902	31	11	3	8	10·77
1903	35	11	3	11	10·04

The total production amounted to these figures in metric tons:—

1899	762,447
1900	744,257
1901	803,735
1902	897,130
1903	952,307

The destination of the sugar is shown in the table underneath, in which the figures represent per cents. of the total exports.

	1898.	1899.	1900.	1901.	1902.	1903.
Holland	4·0	0·7	0·5	0·6	..	0·2
United Kingdom		0·2	0·3			3·0
Azores	1·4	..	..	..	0·7	1·0
Port Said	5·7	1·5	0·8	26·3	1·8	13·1
Delaware Breakwater	12·0	1·3	..	15·5	47·4	14·3
Barbados	2·6	2·6	..	1·2	2·4	6·3
Vancouver	0·4	..	..	2·0	1·4	1·7
United States	44·8	65·3	54·0	0·8	..	1·7
Australasia	0·4	1·8	10·7	12·0	9·9	9·5
China and Hong Kong	21·3	19·0	20·3	27·2	21·0	22·4
Japan	3·0	3·2	5·3	7·4	8·0	15·1
British India	1·4	1·1	3·8	3·0	3·3	7·6
Singapore	3·0	3·3	5·3	4·0	4·1	4·1
	100·0	100·0	100·0	100·0	100·0	100·0

The largest buyers are the United States, Hong Kong, Australasia, and Japan; in the same proportion as our contribution to the American market shrinks, our share of the supply to the more natural markets in Eastern Asia and Australasia increases.

The prime cost of Java sugar was, according to the well-known statistics of Professor van den Berg, in

	Per ton. £ s. d.		Per ton. £ s. d.
1885	10 17 10	1887	8 18 2
1886	10 5 2	1888	8 17 10

interest of capital and debt excluded.

Assuming the average outlay on the capital at £1 1s. 9d. per ton, we may put down the average prime cost in 1888 at £9 19s. 7d. per ton. M. Engelberts calculated the figures for the present day, and fixed them for the year 1900, for the average of 111 factories (or 60 % of the total amount) at £7 10s. 5d. per ton, including all charges of management, agriculture, manufacture, carriage to the coast, upkeep of factory and machinery, buildings, interest on the floating capital, and commissions. This does not include new machinery, used for increasing the capacity of the plant, nor new transport material, nor the interest and sinking fund of the capital invested in the sugar house and appliances. Now we must confess that in 1900 the

circumstances were not favourable owing to rainy weather during the grinding time, but 1901 was not a very good year, though not as bad as 1902. Computing again the cost of interest and sinking fund at £1 1s. 9d. per ton, we have for the years 1901-1902 an average prime cost of £8 12s. 2d. per ton of sugar. There are factories delivering their product at a lower cost, but then on other estates it is correspondingly higher. This with a market price of £8 per ton and even less (the present price being £7 6s. 1d.) is a bad outlook, and we sincerely hope that the time may come when a more remunerative price will be paid for our product, for if the prevailing low prices continue, many a less favoured estate will be obliged to change hands or to become temporarily, if not permanently, closed.

When Professor van den Berg believed in the year 1888 that his average figures represented the limits, below which the prime cost could not be reduced by economisation on pay or on material, and could only decrease, when the science applied to agriculture and manufacture could suggest methods tending to increase the yield of the fields and the output of sugar, he has been confirmed by the results of the last few years, for the prime cost did not sink by mere economy but on the contrary by a bold sinking of fresh funds in the sugar industry, thereby improving the plant and placing the cultural methods on a scientific basis.

The average figure of cane sugar per acre in 1888 was 2 tons 14 cwt., which at an average cost of £9 19s. 7d. have cost £50*, whereas the 3 tons 4 cwt. from the same surface in 1900 at a cost of £8 12s. 2d. have cost £50 13s. 4d.*, so that the lower prime cost per ton of sugar is not obtained by mere economy but by a larger yield. A specification of the cost of sugar not including interest on capital for the year 1902 in an average of 42 factories is given here in £ per metric ton.

	£	s.	d.
Salaries	0	13	4
Cultivation	2	13	4
Transport of cane	0	16	0
Fuel	0	1	1½
Wages	0	3	9
Sundries	0	1	10½
Package	0	4	3
Transport of sugar	0	8	3
Sundry expenses	0	4	6½
Commission	0	7	2½
New machinery	0	15	9
Wear and tear	0	8	6½
Interest	0	8	0
	£7	5	11½

When recapulating the principal features we may observe that the improvements in the cultivation and the manufacture are :—

*There seems a discrepancy in these figures, but we reproduce them as given by Mr. Geerligs (Ed. I.S.J.).

Separation of the two crops, aiming at having at the same time from different fields, quite independent of one another, vigorous and fresh planting material and ripe cane.

Improved means of combatting animal pests, fungoid and other diseases.

Constant chemical analysis of the fields before cutting, so as to ensure cutting ripe cane only.

Accelerated transport of cut cane, by which deterioration of the harvested cane is prevented.

Improved mills and other machinery.

Scientific basis for the chemical control during manufacture.

Green bagasse furnaces, automatic drying apparatus and rail transport, all three making the manufacturers independent of the weather and allowing them to work even in rainy weather and promoting an accelerated and accordingly concentrated crushing time.

What may we further expect from the work of our scientists and planters?

First of all a better cane. In the cultivation of beetroots admirable results were obtained by selection of the richest beets and it would greatly help us if similar improvement could be shown in the case of our raw material. Notwithstanding the notorious improvements, made in the technical province of the sugar industry, the output of sugar per centum cane is not so much increased, thus proving that the sugar content of the cane is rather lower than higher than it used to be; we account for this phenomenon by the heavy manuring which is given to the cane in order to increase the tonnage, but anyhow it shows us that the cane has not yet reached its greatest sugar content and that there is still an opening for improvement. It is not so easy to get a better variety of cane by a sexual propagation, since seed variation occurs much more frequent than bud variation, and therefore the chance of finding a better specimen out of a multitude of individuals is greater when sowing than when planting tops; again, if we have hit upon a superior beetroot, for instance, we can have a few hundreds of thousands of its descendants within a year's time with the least chance of degeneration, whereas the cane in the same time furnishes at the most a few dozens of scions, which are liable to atavism or degeneration before they are propagated sufficiently to plant them out in the field for sugar manufacture. Chemical selection of cane is therefore not so promising as with beetroots, and this explains why the arduous efforts made everywhere to select cane on a chemical basis have not had the same results in the same time as has been the case with the chemical selection of beets. New varieties may however be expected from the scientific crossing of various cane varieties and sowing the seeds obtained thereby. It is a very happy circumstance for us that, unlike the case with the beets, the heaviest and biggest canes are at the same time the richest in saccharine matter, so that a

selection after the size and the weight is at the same time a selection after the sugar content and therefore a double profit. I expect in the near future a considerable increase in tonnage from the same land, which should cause no surprise if we consider that a few years ago a crop of 35 tons per acre was an exception and now it has become a very common occurrence and soon will be an average figure. Exhaustion of the soil by such heavy crops is fortunately not to be feared, as the cane extracts very little from the soil constituents, but forms the greater part of its weight from the water and the carbonic acid out of the atmosphere.

We may next expect a better sugar extraction from the cane by maceration or diffusion of the bagasse, which can yield another 10% of the amount produced now; at present the latter is burnt in the boiler furnaces. Finally the sugar and glucose remaining in the exhausted molasses can find an application either by transforming them into cattle food or by making some industrial use of them.

In this way we try to lower the prime cost of our product on a sound and scientific footing, and though we are aware that it will cost us a great deal of trouble, of expense, and of experimentation to fulfil the task we have laid before us, we all, capitalists, planters, manufacturers and scientists alike are striving to improve the industry, notwithstanding the ruinous prices offered for our sugar.

SOME NOTES ON THE SUGAR INDUSTRY OF MAURITIUS.

By Noel Deerr.

The island of Mauritius, lying just within the Tropics in the South Indian Ocean, has, for the year 1903-04, produced considerably over 200,000 tons of sugar for export; as this cane growing centre is only 705 square miles in area, considerably less than half the area of Trinidad, some information on the local conditions of cultivation and manufacture may be of interest.

Climate and Districts.—The cane is cultivated in Mauritius from sea level to an altitude of 1,400—1,500 feet; on the higher levels at present prices the return is so small that cultivation is barely remunerative, but lower down at the sea level, and up to altitudes of 600—800 feet in favourable seasons, sugar is produced exceptionally cheaply. The island roughly falls into four climatic zones. 1. The northern plain including the districts of Pamplemousses and Rivière du Rempart together with the littoral of Flacq; this district seldom receives more than forty to fifty inches of rain, and is subject to prolonged periods of drought; a few properties systematically irrigate and abandoned estates with ruined irrigation canals can frequently be seen. 2. The central plateau including the districts of Plaines

Wilhelms and Moka together with the greater part of Flacq; this part of the island receives copious rainfalls, in parts up to 200 inches per annum, but lying at an elevation of from 800—1,400 feet, has a mean annual temperature too low to grow heavy crops of cane. 3. The South East part of the island including the districts of Savanne and Grand Port rising from sea level to a height of 600 feet; this zone receives ample rainfall, and contains some of the finest estates in the island. 4. The Black River district forming the littoral on the west of the colony, and characterized by perpetual droughts, the average rainfall not exceeding twenty inches; there are only three estates in this district all growing cane under systematic irrigation; provided a scheme could be carried out for the conservation of the rainfall on the upland districts, this part of the island could produce economically large quantities of cane.

Soils.—The soils of Mauritius are in general light loams draining very easily, in fact too easily, the water-retentive capacity being very low; another factor tending towards dissipation of water is the cavernous nature of the land, the geological formation in many parts being an upper crust of rock and soil over deep caverns; locally the cultivated districts are divided into free and stony soils, apparently volcanic influences have in many parts scattered boulders of rock on the soil; these boulders, too large to be removed without great expense, prevent animal or mechanical tillage. In other parts outcrops of volcanic rocks give to the cane fields an ugly and patchy appearance. In changing rows at replanting the boulders are rolled over on to the old row, and when too large to be moved cane is planted between them, the rows being preserved as well as may be. As regards chemical composition, the writer can only speak of one estate over which he made a soil survey. The soil on this estate contained as the mean of a large number of analyses ·50% lime, ·19% phosphoric acid and ·15% potash, but whereas only traces of phosphoric acid were soluble in 1% citric acid, as a general rule from ·01% to ·02% potash was found available by this method.

Planting.—The crop season commences on plant cane in August and, as owing to the diversity of climate plant cane takes from fifteen months to two years to mature in the different districts, planting operations are being carried on in some parts all the year round. Cane in Mauritius is always planted in holes, 3,000 being reckoned to the acre; the reason for planting in holes instead of furrows is, first, on account of the frequency of strong winds, canes thus planted obtaining a better hold on the soil, and in stony land furrow planting is of course impossible. The other operations of cultivation, weeding, trashing, &c., in no wise differ from those in other countries. It may, however, be mentioned that cane trash is more frequently burnt than buried.

Varieties of Canes and Seedlings.—A very large number of varieties of canes are grown; formerly the Louzier, a cane very similar to, if not identical with, the West Indian Bourbon, was the great sugar producer, but its proclivity towards disease has led to its gradual abandonment. The canes most in favour now are the White and Striped Tanna; the latter is the Cheribon cane of Java, a purple and yellow striped cane of great girth and length, fungus-resistent, but inclined to form short joints; the White Tanna is a bud sport from the Striped and is now held in great favour; it reproduces the best points of the parent cane, at the same time not being so inclined to form short joints; from clinical field observation the writer does not think it is so fungus-resistent as the Striped; the Black Tanna, also a bud sport and much resembling the parent cane in habit, is not extensively grown. All these three varieties are gross feeders and do best when grown on rich soils,* or when liberally manured and watered; they give the best comparative results as plant canes, their superiority over the Louzier being less pronounced in the ratoon crops; over a four crop rotation the writer has no hesitation in putting their superiority over the Louzier at least 25%. Other canes extensively grown are the Port Mackay, a claret cane with inconspicuous but well defined bronze green stripe, and of average height and girth; this cane is characterised by frequently forming variegate or quite white leaves; the Iscambine, a red cane, and the Striped Iscambine, a yellow and green cane, are also frequently seen; both of these are non-resistent to fungus. The classical Horne cane is also sometimes seen on the estate scale.

The history of seedlings in Mauritius is very peculiar; shortly after the discovery by Soltwedel in Java, and by Harrison and Bovell in Barbados, of the fertility of cane seed, seedlings were successfully raised in Mauritius, by Mr. George Perromat; a large number of these were distributed to estates and raised to separate varieties, but the careful systematic work which has characterised the West Indian development of the subject has been entirely absent from Mauritius; each estate which received seedlings numbered them as they thought proper, and as estate managers frequently started seedling nurseries, chaos soon resulted; to cap all a seedling mania arose, and whole fields were put under seedlings of the properties of which nothing was known; provided a new seedling was well advertised, its fortunate proprietor could sell cuttings at fancy prices, to his own great benefit, and frequently to the detriment of the purchaser; of chaos something like order has at last resulted as the outcome of the survival of the fittest, and the following Mauritius seedlings may be mentioned as recognised sugar producers:—

33; a green cane of recumbent habit often forming peculiar abortive joints.

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* Tanna is the native Javanese term for "rich earth."

53 and 65; both purplish canes of average girth and height.

131; a deep purple cane of slender habit but extraordinarily prolific in the number of canes in a stool.

134; a brown cane at maturity of rather less than average girth.

Transport.—Up to 1902—03 the greater part of the crop was transported to the factories by bullock carts holding from half to one ton of cane; this method of transport was the most expensive possible; in that year the "Surra" disease appeared, and practically wiped out the live stock of the island; the result has been a great extension of mechanical transport; in the majority of instances, tramways have been laid down, the favourite gauge being one of 2 ft. 6 in. or thereabouts; the cost per mile, exclusive of rolling stock, has varied from £250 to £350; the cost of laying down the tramways is so variable on different estates, dependent chiefly on the gradients, that no figures can be given; the cars in use hold from two to two and a half tons of cane, a train load consisting of ten to twelve cars; the cost of carriage of canes to the factory inclusive of upkeep etc. is on a well equipped system about threepence per ton per mile; it is a matter of regret that much of the material imported has come from continental firms. Where the estate is very hilly, or intersected by deep ravines, aerial wire ropeways are used; this system is also used to connect up isolated outlying portions of an estate. A number of lightly built steam lorries were introduced to transport cane, but were found altogether too frail for the rough plantation roads; the heavier built traction engines drawing ten to twelve tons have, however, met with an extended use. Large quantities of canes are also transported over the Government system of railroads, the rates charge being 10 cents of a rupee (1·6 pence) for the first, 8 cents (1·28 pence) for the second, and 6 cents (·96 pence) for the subsequent miles; this method of transport, while being very cheap, has the disadvantage that the transport is beyond the purchaser's control, and often results in stale canes reaching the factory.

Cane Farming.—The cane farming industry has made great progress in Mauritius and is largely in the hands of the industrious East Indian immigrants. Estates frequently lease land to farmers and when an estate is abandoned it is often parcelled out and sold on long terms of payment to small planters. When adjacent to a factory the small planter cuts and carts his crop to the factory, but the majority of farmers' canes are carried over the Government rails. The position of the small planter is not a very secure one; in fat years when there is a glut of canes he is often unable to find a market for his crop and in the year when the Surra appeared in many cases he was unable to transport his canes to the mill. He probably does best in lean years when the estate grown canes are not sufficient to keep the mills going full time; the factories then compete for the planters' canes and fancy prices result. The extension of the farming industry may not be

altogether a benefit to the island, for the system of agriculture pursued by the farmer tends towards soil exhaustion and is very different to the excellent fertility-preserving methods envolved by the Mauritian planters.

Pen Manure.—Pen manure is very carefully conserved in Mauritius and it is perhaps due to attention to this point in agriculture that the soils of Mauritius, after continual cane cultivation for so long, can still support large crops of cane. Before the development of mechanical transport every estate kept large herds of oxen and even now considerable numbers are employed to draw the carts used to feed the tramways. During the grinding season the stock are always bedded at night in large pens and also in certain cases during the entre coup. Cane straw is used as bedding and the pens are in a continual state of being cleaned out, fresh litter being continually brought in. As the litter is removed it is piled on stone platforms or stored in pits, the platforms are generally about 100 ft. by 50 ft. and the pits about 10 ft. deep; in either case gutters and wells are provided to catch the liquid drainings which are continually pumped over the heaps of manure; the factory sweepings and filter-press cake are sometimes mixed with pen manure; in certain instances the refuse molasses are also incorporated with the pen manure. The composition of the pen manure varies largely, with 75% of water good manure contains from ·5% to ·7% nitrogen, but where, as often happens, the production of manure is forced beyond its economic limits by bringing in larger quantities of cane straw than necessary as litter, the "manure" may only contain from ·2% to ·3% of nitrogen. In addition to the estate produced manure that obtained from cattle keepers finds a ready sale, and the human excreta from the towns and villages also finds a use in fertilising the cane fields, in fact the Mauritian planter appreciates the benefits of natural manure almost as highly as do the Chinese. The cost of making manure is from Rs. 3·00 to Rs. 4·00 (say from 4s. to 5s.) per ton and the cost of application is about Rs. 0·50 (8d.) per ton; from 15 to 20 tons are applied per acre to plant canes. Sometimes the canes are planted on manure, but more frequently the manure is placed in the cane hole when the canes are from three to five months old.

Artificial Manures.—Mauritius imports large quantities of artificials, the average imports in tons for the five years 1894—1898 being sulphate of ammonia, 3,500-4,000; nitrate of soda, 100-120; superphosphate, 1000-1,100; other phosphates, 300-350; nitrate of potash, 1,800-1,900; sulphate of potash, 120-130; guanos from Seychelles and some neighbouring islands, 6,000-8,000; in all say, per annum, 250,000 cwt: allowing that 125,000 acres are manured annually, this would give an average of 2 cwt. of artificials per acre; but as the East Indian cane farmer is extremely sparing of manure, this estimate would indicate that the properly worked estates

use considerably more than 2 cwt. of artificials per acre. The guanos from Seychelles, referred to above, are phosphatic guanos containing little or no nitrogen.

Green Manuring.—The general system of rotation is to grow cane for five years up to third ratoons, after which the land is cleaned and put under leguminosae for from one to three years.*

Diseases—Practically all reported diseases of the cane can be noticed in Mauritius: root and rind fungus are common, the Louzier or Iscambine being especially attacked; the *Ustilago Sacchari* is not infrequent, and shows a preference for young cane; occasionally fields bearing every outward symptom of sereh as described in Went's and Wakker's treatise, can be seen; the Top Rot of Java, recently described by Grieg Smith as due to *Bacillus Vasculorum*, and characterised by gummosis is also fairly common, as also are a large number of leaf diseases.

Factories.—In common with other cane growing centres a great deal of centralisation has taken place in Mauritius, but in general the factories are patchwork concerns compounded out of two or three small factories with machinery fit only for the scrap heap. Comparatively little new machinery has been imported, and what is now in use is of mediæval design, so that the average Mauritian factory forms an excellent museum of antiquated types of machinery. The points which are most striking are the large number of old mills of the solid headstock type, the cumbersome beam pumping engines many of which are fifty years old, the small shallow copper vacuum pans, and worst of all the fixed centrifugals driven by means of two friction cones. The boilers are nearly always multitubular and the few water tube boilers which have been erected have not given satisfaction; the boilers are hung so as to give a two way pass only to the flue gases, and as the furnaces are built with absolutely no combustion chamber, fuel consumption is consequently high; coal and wood are, however, but little used, the general fuel, other than megass, being cane straw. A factory normally firing four furnaces will in general have one continually fired with cane straw.

Market.—The sugar market is controlled by East Indian merchants against whom there is a periodic outcry. Mauritian merchants have only themselves to blame for allowing the sugar trade to pass into the hands of these commercially dangerous competitors, but instead of combining and attempting to regain the lost control, their energies seem to be confined to writing letters to the local press complaining of the machinations of the wicked East Indian.

General Prospects.—In Mauritius, canes can be grown as cheaply as in any country, and the Mauritian has very little to learn regarding agriculture, but as already indicated, the factories are capable of

* This system will be referred to in a subsequent article.

great improvement; at present, however, the money required to erect modern factories is not available. The market to which the greater part of Mauritian sugars go is India, and now, owing to Javanese competition, there is a prospect of over production and consquent low prices. The hope of Mauritius lies in the devolopment of the South African market; before this market can be developed, Mauritian merchants must combine so as to obtain steamers to carry cargoes at fairly reasonable rates.

MANUFACTURE OF ALCOHOL FROM SUGAR BEETROOTS.

By Sigmund Stein,
(The Sugar Institute, Liverpool).

Eighteen months ago I published in this Journal an article dealing with the manufacture of alcohol from sugar beetroots. Since that time great interest has been aroused in the matter. I am constantly receiving letters from interested parties, people of all classes, and even from very high authorities. So, the literature on the subject being very limited, I propose to contribute a few papers dealing with this question.

In my former article I mentioned the technical part of the manufacture and distilling, and gave the yield, and the process. In the present article I shall enumerate the great advantages to be derived from the manufacture of cheap alcohol for industrial purposes, and the benefits to be obtained not only by the farmers but by different industries, if alcohol is made duty free and sold at a cheap price.

But the scheme must be supported from high quarters if it intends to attain a success. In Germany a few years ago, when the exhibition of the alcohol industry took place at Berlin, the German Emperor and his sons visited it. When the Emperor saw the wonderful extent to which the use of alcohol could be put, he expressed great surprise and pleasure. Just now an exhibition is being held at Vienna, with the sole object of pushing the alcohol industry and exhibiting all objects connected with the same; such objects and utilizations will be described further on. The Austrian Emperor and Imperial Princes visited this exhibition and were also very much surprised at what they saw. I wonder if such an exhibition could not be arranged in our own country, just to show our people what could be done if alcohol could be made duty free and generally utilized.

The motor industry is spreading very fast in this country, and its progress might be further accelerated if the unrestricted use of alcohol for motive power could be ensured. The question of cheap alcohol is thus of considerable importance, not only to the chemist and to the alcohol manufacturer, but to the technical man, the farmer and to every political economist. Even for the medical profession it

has a great value. The chemist can and is working with all energy to increase the yield of alcohol, and he is now supported in his endeavours by the farmer, who does his best in regard to the selection of the seed for the raw material and its proper cultivation. We have arrived to-day at a point where we are not only producing the greatest quantity of raw material per acre, but also the highest content of starch and sugar.

When Professor Maerker, in writing his book on the manufacture of alcohol, mentioned the *theoretical* yield, and the yield which could in practice be obtained in a distillery, he would have been surprised if he had been told that his theoretical yield would eventually be reached in practice. The production of alcohol as mentioned in my former paper is increasing in every Continental country. Unfortunately, however, the increase in the United Kingdom is in no proportion to the Continental one.

Its production meets with much opposition from the temperance party, and it may be said that the latter have something to do with our present small output of industrial alcohol, and that they put every obstacle in the way of the foundation of an alcohol industry. It is doubtless a very laudable purpose from the hygienic and ethic point of view which inspires the temperance party to do everything in their power to limit the consumption of alcohol as human food. The object of the scheme, however, is to assist agriculture and benefit numerous industries by supplying them with a cheap and efficient fuel or motive power. From this standpoint, therefore, everything possible should be done to help and increase the production of sugar beetroots and potatoes. This fostering of the alcohol production brought at one time an over production of alcohol, but it was at a period when there was no thought of using alcohol in an industrial way. Since then societies have been formed for the purpose of encouraging such a utilization of alcohol. These societies work very hard by issuing pamphlets, writing to the papers, and instructing the population in the benefits to be secured by the use of alcohol instead of other substances for heating and lighting purposes. Many experiments have been made in this direction. It was found that one kilogramme of alcohol of 90% gave on burning 5,500 calories and that it is not only a material for heating and lighting but also for use in explosion motors.

If one supposes that one acre of land produces 6 tons of potatoes and these 6 tons produce 150 gallons of alcohol, it is calculated that with it a motor-car of 5 horse power could be driven 8 hours a day for 3 months.

As above mentioned a society exists in Germany for pushing forward the use of alcohol for industrial purposes; it also pushes the sale of apparatus and utensils in which alcohol may be applied.

The German Emperor himself supported the scheme and spoke and interested himself in it on many public occasions. The German

government offered prizes, encouraging the manufacture of spirit lamps, and furthermore reduced the duty on denaturated alcohol. They also ordered the use of spirit lamps for the State railways, barracks, &c. Of course such valuable patronage must show some result, and whereas Germany consumed in the year 1891-1892 about 2,700 hectolitres of denatured alcohol, we find that in the year 1901-1902 780,000 hectolitres were consumed. This movement in Germany not only had a good influence on the country, but was of great importance for the reason that other countries saw it and were led to tackle the subject.

Germany we see was the pioneer in the movement, but France soon followed, and in the latter country we find societies formed for using alcohol for industrial purposes similar to that described above. It is well known that France was the first country in which alcohol-driven motor-cars were tried and also manufactured on a large scale. It should be mentioned that the Automobile Club in Paris did a great deal for this movement. The great race about two years ago showed to the public, that not only petroleum and benzine could be used for motor purposes but alcohol also. The French government arranged a conference of experts on the 11th March, 1903, for the discussion of the utilization of alcohol for industrial purposes. The French Minister of Finance formed a Commission which was to help him in studying the question. We find on this Commission not only technical men and chemists, but also former ministers of Finance, who have all the material, data, and figures at hand and who are international correspondents. If a movement is supported in such a way from high quarters its success can hardly fail to be assured.

Austria followed the example of France very quickly. The Austrian Minister of Finance issued a decree in November, 1903, in which he stipulated that alcohol to be used for motor purposes should be duty free.

Russia has as well instituted a Committee for the study of this important question, and the Russian Government has come forward with a practical suggestion. It has offered a prize for a new medium of denaturation, to the value of 5,000 roubles.

Other countries, like Italy, Spain, Belgium, and Roumania, have taken up the matter, and in all of them Committees have been formed; and, as I mentioned in my last paper, Peru had an exhibition for alcohol last year. But turning to England, it is unfortunate to find that we have done nothing here to foster the use of alcohol for industrial purposes.

As I mentioned, I have been asked for popular information about distillation and fermentation. The following lines are not written for an expert, but are only for readers who wish to get a short outline of the processes which are carried on in a distillery.

The raw material for the manufacture of alcohol can be divided into three groups:—

No. 1. Such substances which already contain alcohol, and from which, by distillation only, the alcohol can be obtained. One of these substances, for instance, is wine. If wine is distilled, cognac is obtained.

No. 2. Materials which contain sugar. Amongst these the sugar beetroot is the principal factor. France, for instance, manufactures one-third of all her alcohol from sugar beetroot. That Germany and Austria do not at present follow the same plan is purely for certain fiscal reasons. In the same group must be mentioned the beet molasses, a by-product in the manufacture of sugar. In this case the sugar must be brought to fermentation, as described in my former article. Besides alcohol and carbonic acid other substances are formed, which are called fusel oils; these latter give to the alcohol a bad smell and taste. For this process of distillation certain ferments are necessary. Among these may be mentioned *yeast;* there are other substances which are in many animal and plant organs, and which are extracted from the organism and form a powder which is called "Enzyme." The latter plays a principal part in the process of life, and is able to cause many different transformations. These ferments work only at one temperature, and if this temperature is exceeded their action is lessened or stopped entirely.

No. 3. In this group are raw materials for alcohol manufacture, which contain the substance *starch.* There are many plants containing starch, but originally in the manufacture of alcohol, only corn, maize, wheat, or barley were used. The U.S.A. and Hungary use maize in great quantities for distillation. Germany and Austria use chiefly potatoes. In many instances, where yeast has to be made, other kinds of grain are used. The transformation into fermentable sugar was described in my former article.*

In fermentation the quantity of yeast is increased, and on this is based its manufacture. The making of yeast without fermentation is not possible. If, however, the manufacture of yeast as the principal product is required, the process must be so arranged that the growth of the yeast is favourable, without taking any regard to the yield of alcohol.

The fermentation can be either a top fermentation or a bottom one, according to the kind of yeast which one employs. A top fermentation occurs at a higher temperature (15 to 22° C.), and the yeast appears on the surface of the fermentation vessel. The bottom fermentation occurs at a lower temperature (5 to 6° C.), and the yeast settles as a yellow precipitate at the bottom of the fermentation vessel. In the brewing industry both kinds of fermentation are used. The bottom fermentation is used if a beer is to be manufactured

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* See *International Sugar Journal,* 1902, p. 602 and 637.

which is to be kept for a considerable time. This fermentation is, however, very much more expensive than the other one.

In distilling, however, top fermentation is used. As the yeast cannot be separated properly and easily from all of the available materials, it is, therefore, made solely from grain. In latter years, attempts have been made to manufacture yeast from potatoes, and with good results. The yeast, which appears as a yellow froth driven by the carbonic acid to the surface of the fermentation vessel, is mixed with froth and the husk from the grain. It is then ladled off and put through sieves with small meshes. In this way the yeast is freed from the husks, afterwards it is washed with water several times, and allowed to settle for a time. The water is then drained off and the yeast after being cleaned between filter cloths, is pressed in filter presses, and formed into solid cakes. These cakes are put in a certain machine to be worked into long skeins and then cut into pieces of a certain weight.

Application of Alcohol in Industries.

Alcohol is used very extensively in different industries, and if these industries could obtain it free of duty they could be extended on a very large scale, to the benefit of the manufacturers and the population in general. A few of the industries which depend upon the use of alcohol are herewith mentioned.

1. *The manufacture of Artificial Silk.* This is a product which has sprung up during the last few years. The best known process is that of Chardonnet. According to it the celulose of the timber is transformed by nitrating into nitro-celulose. The latter is treated with alcohol-ether to a certain consistency, and the whole mass is heavily pressed (50 atmospheres) through very narrow tubes, and the mass becomes solid under the atmospheric pressure. This substance can be tinted with choice colours, and represents the artificial silk the brilliancy of which leaves nothing to be desired, and which is largely used in the textile industry.

2. *The manufacture of Collodium-wool.* This is nothing less than a nitrated celulose which is perfectly soluble in ether-alcohol, and which is used in photography, in medicine, in the manufacture of celluloid, and in the explosives industry.

3. *Smokeless powder* requires alcohol-ether for its manufacture.

4. *Ether.* The substance ordinarily called sulphur-ether, because it is manufactured from alcohol with the aid of sulphuric acid.

5. *Chloroform and Iodoform.* Both these substances require alcohol for their manufacture.

6. *Tar Colours.* Alcohol is used in this industry for the er-crystallisation of many products.

7. *For mxking many Perfumes.* These are simply extracts from different plants, which are dissolved in alcohol.

8. *The manufacture of Toilet Soap.* These beautiful soaps of great transparency are manufactured by the dissolving of the soap mass in alcohol.

9. *Lacquers* are nothing else than resin dissolved in alcohol, and if the latter is evaporated there remains a fine, hard, bright product, which is used very extensively in commerce.

10. *Treatment of Wine with Alcohol.* This is done for the purpose of improving the wine, and is used in the place of sugar. By this means the fermentation is interrupted before all the sugar is fermented. Malaga and Madeira wines are treated in this way for their preservation, and are thus better able to stand transport.

11. *The preserving of animal preparates.*

12. *The manufacture of compressed Alcohol.* A product just lately manufactured, and used especially by tourists. For its manufacture substances are used which are capable of forming with alcohol plastic and gelatinous masses. These, in burning, either leave a sediment or burn away with the alcohol. These masses are compressed into the form of tablets or pastilles.

13. *Vinegar.* The manufacture of vinegar from alcohol dates back to the year 1823. In that year Professor Schützenbach explained and described this mode of manufacture, and it has hitherto been done according to his old method: Diluted alcohol of about 10% is mixed with a little vinegar, and beer or malt extract. This mixture is poured out into large vats which possess two bottoms. Between these two bottoms there are scraps of wood shavings. Through perforations on the circumference of the vats the necessary air can enter. The room in which the manufacture of vinegar takes place should be at a temperature of about 25° C., and the temperature in the vats about 35° C. The vinegar which runs off at the bottom consists of about 5% to 6% of acetic acid. The product so received can be concentrated by means of diluted alcohol, and this mixture is brought again into the vat. By this means a vinegar is formed containing 10% to 12% of acetic acid.

14. *Fruit Essences* are alcoholic solutions of a mixture of different ethers which have the characteristic smell and taste of certain kinds of fruits. These essences ars used very extensively for imitating the flavour of fruits, for cooking purposes, confectionery, and in the manufacture of liqueurs.

15. *Chlorine Compounds (also Bromine and Iodine Compounds) of Ethyl* are manufactured from alcohol, and are used in the production of tar colours. Brom-ethyl is used as an anæsthetic in dentistry.

Application of Alcohol for Lighting.

It is well known that alcohol burns with a non-luminous flame. It must therefore be combined with a substance which makes it luminous. This combination is called carburation. Another way of using alcohol for lighting purposes is to mix the vapour of alcohol

with air over an incandescent mantle. Alcohol has the advantage over petroleum that it burns perfectly free of smuts, and has no smell. Two systems of lamps have been contrived for using it.

1. Those in which the alcohol is brought to evaporation by a small flame. These vapours are mixed with air and brought over an incandescent mantle.

2. Those in which the evaporation of alcohol is accomplished in a tube which is inside the incandescent mantle, and which becomes hot by the heat arising. The alcohol is brought to the incandescent mantle by a wick. Lamps of the first type required another flame for evaporation. The second kind must be heated one or two minutes before the lighting takes place. It has been proved by many experiments that lighting with alcohol is 30 or 40% cheaper than lighting with petroleum. I saw last year in Berlin dozens of different systems of alcohol lamps, and I am anxious to see the general use of alcohol for lighting purposes applied also in this country.

Price of Alcohol.

The question is asked whether alcohol for industrial purposes can compete with petroleum as regards price. Professor Delbrück calculated that the proportion in price, relatively speaking, of petroleum to alcohol can be fixed at the ratio of 1 to 2. That is to say, if a gallon of petroleum cost 4d., one of alcohol can be said to cost 8d. The question is, can alcohol be manufactured at that price? Professor Delbrück came to the conclusion in a lecture delivered on the 23rd April, 1904, at Vienna, that it could be done. He said, "Alcohol which is made from sugar beetroots can very well compete with petroleum, and the light produced therefrom will satisfy everybody; and the production of this alcohol will be a boom to agriculture. In time to come the number of distilleries will be doubled or even quadrupled, and the increase in the production of this spirit will yield cheap fodder for stock."

The duty on alcohol is everywhere only a tax on consumption. From this standpoint it is perfectly justified, considering the moral harm caused by its excessive use for drinking purposes; and taking into consideration the welfare of the country in general, I think it is only right that alcohol should be taxed if used as food or drink. In Germany the Government realized the matter at once from this standpoint, and taxed the alcohol for comsumption very heavily, to the benefit of the alcohol which was used industrially. Another important point is the cost of denaturing the alcohol, which should be very low. The denaturating mediums that are applied should be used in very small quantities, so that the expense will be a minimum, and full guarantee would have to be given that the alcohol will not be used for drinking purposes. The denaturating mediums should be not only cheap, but should be obtainable in large quantities, so that when they are used extensively it may not influence the price of the

alcohol. Furthermore, it is of importance that the price of alcohol should not fluctuate, but should remain at a cheap level. Again, alcohol should be used generally everywhere, and by everybody, and the public should be educated to that end, so that they may get confidence in the use of the article. It is advisable to form associations, like those they have in Germany and France, for the quick and easy sale of cheap alcohol. Nothing arouses public interest better and helps a new industry than exhibitions at which prizes are given to the competitors in different branches of the industry. The Press could take the matter up, and start a propaganda in that way. Everybody interested in the question should write to the papers dealing with the subject.

Finally, manufacturers of alcohol and all those interested in the creation of this industry should do their best to set the scheme on its feet.

(*To be continued.*)

Correspondence.

TIN IN SUGAR.

To the Editor of "The International Sugar Journal."

Sir,—In your publication for June there is a most interesting paper on "The Investigation of the Proportion of Tin found in Sugar." So much has been said on the use of tin in the manufacture of sugar in Demerara, that I may perhaps be excused for calling attention to the remarkable results of that investigation. It would appear from the analyses given on page 295 that the quantity of tin found in yellow sugar is practically the same as that found in the dark crystals, viz.: ·0112 tin chloride per cent. in yellow crystals, ·01 in dark crystals. Now, it is well known that tin chloride is never used in the manufacture of dark crystals, and, it would appear therefore that, whether it is used or not, the result in the manufactured sugar is the same. The quantity of course in either case is quite insignificant, but, it is a little curious that there should be no difference in the quantity found in the two cases.

Your obedient servant,

20, Eastcheap, London, E.C., N. Lubbock.
13th June, 1904.

WEINRICH'S NEW PROCESS.

To the Editor of "The International Sugar Journal."

Sir,—In your May number a letter was printed from Mr. O. B. Stillman in which he asserts that my process of treating sugar cane, of which a short description appeared in your March number, is "practically identical" with a process introduced by him years ago.

This attack compels me to answer and I think the best way is to set forth in as few words as possible the object and the essential features of the two methods.

What I learn from Mr. Stillman's letter and from Mr. James W· Donald's description given in your March number, the object of his process is "to avoid the formation of vitrious slag formed in the "furnaces of bagasse burners. The *modus operandi* differed from "that followed in other Hawaiian factories, principally in the liming "of juices, which was done by pumping very dilute milk of lime as "maceration water after first mill, whereas water was used after the "second mill. The greatly overlimed juice from the second and "third mills mixed with the normal, unlimed juice from the first mill "and the mixed juice was pumped to the upper end of a sulphurizing "tower, from whence it flowed zig-zag to the lower end while being "charged with sulphur fumes. It was then heated from 190° to 200° "and entered the circular defecating tanks (clarifiers) where the "juice was brought to the proper temperature and left to settle. "Sulphurating was only used when needed. The settlings were "heated, limed and pumped to the filter-presses without being "perceptibly diluted. The cake was washed in the press in the usual "manner and it contained when discharged: Max. 3·5% ; min. 1% and "average 2·75% sugar."

This shows that about 80% of the available juice is obtained in the ordinary way from the first mill and that the juice coming from the second and third mills is simply made strongly alkaline, but not defecated, by using very dilute milk of lime as maceration water, leaving part of the lime in the bagasse, the latter being the main object of the process. The mixed juice is *then* heated and defecated and the settlings pumped through filter-presses as done on almost all plantations.

The object of my process is to defecate all the juice completely *while still in the cane*, and to retain most of the defecation scum in the bagasse, thus dispensing with defecation and filter-press plants.

To attain this object I suggested shredding the cane by some suitable device into fibres, then soaking the shredded cane-mass with boiling lime-water or thin milk of lime, and heating it in some other suitable device to about 185°F., thus ensuring complete defecation of all the juice *before any of it is extracted*. After this the treated cane-mass undergoes the ordinary milling process, which gives forth only defecated juice, while most of the defecation scum remains in the bagasse. If necessary the alkalinity of the juice is then corrected in the well-known way, and the juice is run over some mechanical filter before it enters the triple effect.

This will show convincingly that these two processes are two very different things, and that Mr. Stillman's attack has been entirely unwarranted.

You will oblige me by inserting this in your valued journal.

Yours faithfully,

Yonkers, N.Y., MORIZ WEINRICH.

June 1st, 1904.

IMPORTS AND EXPORTS OF SUGAR (UNITED KINGDOM)

To end of May, 1903 and 1904.

IMPORTS.

Raw Sugars.	Quantities. 1903. Cwts.	Quantities. 1904. Cwts.	Values. 1903. £	Values. 1904. £
Germany	1,562,703	3,013,065	623,780	1,313,289
Holland	118,455	75,204	44,721	30,798
Belgium	539,647	155,266	225,212	65,672
France	272,250	95,880	124,013	42,957
Austria-Hungary	1,147,185	659,135	482,741	298,846
Java	....	706,743	....	298,891
Philippine Islands	70,646	....	25,285	....
Cuba	131,095	....	62,490	....
Peru	111,836	403,263	42,758	180,322
Brazil	51,584	81,115	20,249	30,996
Argentine Republic	78,345	....	34,949	....
Mauritius	162,036	158,680	57,092	59,258
British East Indies	67,203	98,108	25,448	38,954
Br. W. Indies, Guiana, &c.	358,779	570,397	225,209	370,997
Other Countries	158,550	322,217	67,497	146,541
Total Raw Sugars	4,830,314	6,339,073	2,061,444	2,377,521
Refined Sugars.				
Germany	5,664,614	4,633,766	2,933,423	2,583,508
Holland	835,976	1,331,958	483,949	778,013
Belgium	71,172	189,707	42,193	106,734
France	365,070	953,384	209,635	512,005
Other Countries	400,660	162,142	197,998	85,683
Total Refined Sugars	7,337,492	7,270,957	3,867,198	4,065,943
Molasses	630,319	770,240	120,294	136,491
Total Imports	12,798,125	14,380,270	6,048,936	7,079,955

EXPORTS.

British Refined Sugars.	Cwts.	Cwts.	£	£
Sweden and Norway	9,747	10,939	5,079	5,531
Denmark	35,145	46,158	19,135	23,632
Holland	25,735	24,861	14,015	12,937
Belgium	3,378	4,425	1,648	2,413
Portugal, Azores, &c.	2,873	5,180	1,558	2,734
Italy	4,552	1,727	2,070	810
Other Countries	204,647	134,574	123,749	83,147
	286,077	227,864	167,254	131,204
Foreign & Colonial Sugars.				
Refined and Candy	13,092	11,354	8,297	7,770
Unrefined	23,873	47,594	12,374	25,976
Molasses	1,117	144	583	60
Total Exports	324,159	286,956	188,508	165,010

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1904. Tons.		1903. Tons.
Total Receipts, 1st Jan. to June 16th ..	952,987	..	876,472
Receipts of Refined ,, ,, ,, ..	225	..	734
Deliveries ,, ,, ,, ..	938,730	..	800,745
Consumption (4 Ports, Exports deducted) since 1st January	798,917	..	690,496
Importers' Stocks (4 Ports) June 15th ..	26,418	..	80,112
Total Stocks, June 22nd	224,000	..	324,928
Stocks in Cuba ,, ...	170,000	..	344,478
	1903.		1902.
Total Consumption for twelve months ..	2,549,643	..	2,566,108

CUBA.

STATEMENT OF EXPORTS AND STOCKS OF SUGAR, 1903 AND 1904.

(Tons of 2,240lbs.)	1903. Tons.		1904. Tons.
Exports	492,653	..	775,327
Stocks	371,941	..	236,942
	864,594	..	1,012,269
Local Consumption (five months)	17,230	..	18,240
	881,824	..	1,030,509
Stock on 1st January (old crop)	42,530	..	94,835
Receipts at Ports up to May 31st.. ..	839,294	..	935,674

Havana, May 31st, 1904. J. GUMA.—F. MEJER.

UNITED KINGDOM.

STATEMENT OF IMPORTS, EXPORTS, AND CONSUMPTION FOR FIVE MONTHS ENDING MAY 31ST.

SUGAR.	Imports. 1904. Tons.		Imports. 1903. Tons.		Imports. 1902. Tons.	Exports (Foreign). 1904. Tons.		Exports (Foreign). 1903. Tons.		Exports (Foreign). 1902. Tons.
Refined	363,548	..	366,874	..	496,992	567	..	654	..	939
Raw	316,954	..	241,516	..	370,781	2,379	..	1,194	..	1,375
Molasses	38,512	..	31,516	..	25,819	7	..	56	..	57
Total	719,014	..	639,906	..	893,592	2,953	..	1,904	..	2,371

	Home Consumption. 1904. Tons.		1903. Tons.		1902. Tons.
Refined	377,955	..	343,401	..	499,221
Raw	51,355	..	224,037	.	361,505
Molasses	33,874	..	29,600	..	26,948
Total	463,184	..	597,038	..	887,674
Less Exports of British Refined	11,393	..	14,304	..	12,084
Home Consumption of Sugar imported from Abroad..	451,791	..	582,734	..	875,590
,, ,, ,, Refined (in Bond)......	209,354	..	—	..	—
,, ,, Molasses, manufactured (in Bond)	26,866	..	—	..	—
Total Home Consumption of Sugar	688,011	..	582,734	..	875,590

STOCKS OF SUGAR IN EUROPE AT UNEVEN DATES, JUNE 1ST TO 22ND, COMPARED WITH PREVIOUS YEARS.

IN THOUSANDS OF TONS, TO THE NEAREST THOUSAND.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	TOTAL 1904.
103	906	635	331	197	2173

	1903.	1902.	1901.	1900.
Totals	2196	2326	1468	1307

TWELVE MONTHS' CONSUMPTION OF SUGAR IN EUROPE FOR THREE YEARS, ENDING MAY 31ST, IN THOUSANDS OF TONS.

(From Licht's Monthly Circular.)

Great Britain.	Germany	France.	Austria.	Holland, Belgium, &c.	Total 1903-4.	Total 1902-3.	Total. 1901-2.
1770	979	653	451	542	4395	3774	4114

ESTIMATED CROP OF BEETROOT SUGAR ON THE CONTINENT OF EUROPE FOR THE CURRENT CAMPAIGN, COMPARED WITH THE ACTUAL CROP OF THE THREE PREVIOUS CAMPAIGNS.

(From Licht's Monthly Circular.)

	1903-1904. Tons.	1902-1903. Tons.	1901-1902. Tons.	1900-1901. Tons.
Germany	1,950,000	1,762,461	2,304,923	1,984,187
Austria	1,165,000	1,057,692	1,301,549	1,094,043
France	790,000	833,210	1,123,533	1,113,893
Russia	1,200,000	1,256,311	1,098,983	918,838
Belgium	210,000	215,000	334,960	333,119
Holland	125,000	102,411	203,172	178,081
Other Countries	410,000	325,082	393,236	367,919
	5,850,000	5,552,167	6,760,356	5,990,080

THE

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☞ The Editor is not responsible for statements or opinions contained in articles which are signed, or the source of which is named.

NOTES AND COMMENTS.

Blyth Bros., Mauritius, report shipments of sugar from August 1st to 1st June as 199,850 tons, as compared with 137,457 for the same period of 1902-03.

Denaturation of Sugar.

According to the *D. Z. I.*, the denaturation of sugar can be accomplished by adding 1% of petroleum. In this condition it can be used for the manufacture of transparent soaps. The very pronounced odour resulting renders it unsuitable for domestic uses.

The Leaf Hopper in Hawaii.

Some reference was made in an earlier number of the *Journal* to the depredations wrought by a new pest styled the "Leaf Hopper" in Hawaii. We now learn from the *Louisiana Planter* that Prof. Alexander Craw, the horticultural expert of California, has been commissioned to visit those islands and endeavour to exterminate this pest. The parties inviting him are the Hawaiian Government and the Hawaiian Sugar Planters' Association, and they have guaranteed him $5,000 per annum for five years. He will be at the head of the entomological bureau. As the loss of the planters last year from the "Leaf Hopper" ran into millions of dollars, Prof. Craw's advent should be welcomed. Previous to his appointment, Professors Koebele and Perkins did something to materially reduce the ravages of this insect, but these gentlemen lately left for Australia. Hence the new appointment.

The Beet Sugar Gazette.

This enterprising organ of the American beet sugar industry has lately decided to enlarge the scope of its operations and include within its pages matter dealing with the whole American sugar industry. With this laudable object in view, it has seen fit to name itself anew. Under the title of *The American Sugar Industry and Beet Sugar Gazette*, it will doubtless now endeavour to cater as well for the American cane industry, in spite of the latter already having two periodicals devoted to its interests. Anyhow this new step suggests either that, Cuba or no Cuba, the American sugar industry is now in a flourishing condition and likely to remain so for some time, or else, that the beet sugar industry is in process of reduction to such narrow limits that the *Gazette* finds it necessary to seek fresh fields and pastures new in order to maintain its position.

SCIENCE IN SUGAR PRODUCTION.

By T. H. P. Heriot, F.C.S.

(*Continued from page 329.*)

4. Manufacture.—(*Continued.*)

(*b*) *Purification of the Juice.*

The various methods of extraction reviewed in the preceding paper have for their object the separation of juice from the solid structure of the raw materials. The residues thus obtained, although practically free from sugar, are valuable by-products of their respective industries, as will be hereafter shown.

Pursuing our main enquiry, we have first to follow the saccharine juice from the moment of extraction until its contained sugar assumes the crystalline form, ready for shipment.

The raw materials of the two industries contain the following approximate percentages of crystallisable sugar, or sucrose:—

	Per cent.
Cane (West Indies)	13 to 14
Beet (Germany)	14 to 15

This sugar is dissolved in the juice which constitutes nearly 90% of the weight of the cane-stem, and approximately 99% of the weight of the beetroot. When the cane is milled, and the beetroot rasped and pressed, the extracted juices are found, on chemical analysis, to have the following mean composition:—

		Cane Juice. Per cent.	Beet Juice. Per cent.
Water		79 to 82	80 to 81
Sugars	Sucrose	14 to 16	14 to 15
	Glucose	1 to 1·5	Trace
Impurities	Organic	0·5 to 2·0	3 to 4
	Mineral (ash)	0·3 to 0·5	0·8 to 1

There is, therefore, a close similarity between the two liquids, although the proportion of impurities is higher in the juice of the beetroot. These impurities hinder the crystallisation of the sugar at a later stage, and their removal is, therefore, a matter of prime importance to the manufacturer.

All methods of purification involve two steps—first, a chemical treatment by which the impurities, being rendered insoluble, are precipitated in the solid state; and secondly, a mechanical treatment whereby the precipitated impurities are separated from the purified juice.

The Cane.

When extracted by the mill, the raw cane juice is a dark, opaque liquid, having a sweet taste, pleasant odour, and a density varying between 1·06 and 1·08. In addition to the dissolved impurities already mentioned, the raw juice contains a considerable quantity of suspended impurities, such as particles of cane-fibre, wax, etc., also innumerable minute air bubbles which, rising to the surface, form a thick froth. On contact with the air, the mill, the strainers, and gutters through which it flows, the juice rapidly becomes infected with another and more insiduous form of impurity, namely, the micro-organisms which cause fermentation, acidity, and kindred troubles. The cold juice being very viscuous, cannot be filtered, but a partial separation of suspended impurities is effected by means of strainers through which the juice flows from the mill.

The juice, being a dilute solution of sugar, must be concentrated to a syrup by the aid of heat, and, during this necessary operation, the ferments are either destroyed or rendered inactive, hence the importance of heating the juice immediately after it leaves the mill. This antiseptic action is accompanied by a partial purification of the juice resulting from the coagulation and precipitation of part of the albuminous impurities. On the other hand, heat has an injurious effect by causing what is known as "inversion," that is, the partial conversion of crystallisable sugar into uncrystallisable forms. Inversion is accelerated in the presence of acids, and the slight acidity of fresh cane juice is sufficient to cause an appreciable loss of sugar when the liquid is boiled; whilst in the case of sour juice, extracted from diseased or rotten canes, the inversion may be sufficient to destroy the whole of the crystallisable sugar present.

As a method of purification, the action of heat alone is far from satisfactory, and some form of chemical treatment has been adopted from the earliest times. By way of historical introduction, we may quote the following curious passage from Rumphius describing the art of sugar manufacture as early practised by the Chinese:—

"The expressed juice is received into large boilers, placed over brisk fires; as the juice evaporates, more is added, till it becomes red and thick; then it is put into large deep earthen vessels, which are

taken to a warm place. The sugar at the surface forms crystals, which are united in white clusters, called *cakes of sugar,* and that which crystallises underneath is called *Muscovado.* The sugar is refined by being clarified in great boilers, with white of eggs; a little chicken fat is used in the operation; it is afterwards put in large earthen plates to crystallize. That which is obtained from the *cakes of sugar* is very white and hard, resembling crystal, and is called *male sugar;* that which is obtained from the *Muscovado,* the crystals of which are sweeter and less hard and fine, is named *female sugar.*"

The natives of the East Indies appear to have used ordinary milk for purifying the juice during the process of boiling; also the juice of a species of mallow which they planted for that purpose. Rumphius does not mention the use of lime, or other alkalies, and, as the accuracy of this naturalist is well known, we may conclude that the Chinese and Indians did not use them.

DEFECATION.—The value of lime for purifying cane juice was known and utilized at a very early date, certainly before the cane was first planted in Barbados in 1641. By defecation is meant the addition to the juice of a small quantity of lime (in the form of "milk of lime"), the liquid being subsequently heated nearly to the boiling point. As an alkali, lime serves to neutralize the natural acidity of the juice, thus reducing the risk of inversion during evaporation. It renders insoluble the whole of the albumen but only a small portion of the gums and pectine, together with some mineral phosphates. The precipitate, thus formed, envelopes the suspended particles of fibre, wax, &c., forming a complex mixture of impurities which are suspended in the juice.

Three distinct methods have been employed at one time or another for the mechanical separation of these solid matters.

Skimming.—On gradually heating juice to which lime has been added, the suspended air bubbles expand and, rising to the surface of the liquid, carry with them the suspended impurities which form a thick scum. These impurities are, in reality, heavier than the juice, but are buoyed up by the entangled air bubbles.

In the old method of open evaporation by the "copperwall" this scum was removed by hand-skimmers as fast as it was formed, but no attempt was made to separate the denser matter which remained in suspension after the air had been expelled by boiling the liquid.

Subsidation.—A much more perfect separation was obtained by the application of high-pressure steam for heating the juice in special defecating pans, in which the operation was under better control. The juice being limed cold, steam was admitted to a chamber which surrounded the lower part of the pan. As the juice became heated, a thick scum of impurities rose to the surface of the liquid, the heating being continued until bubbles of steam began to burst through the surface layer of scums, technically known as the

"cracking point." The supply of steam was then shut off and the vessel left undisturbed for some time. In this manner there resulted a separation of the impurities into two portions; a thick blanket of scum on the surface and a sediment at the bottom of the vessel, whilst the intermediate large bulk of juice remained bright and clear. By means of outlet cocks, the clarified juice was then run off into one receiver, and the scum and sediment into another.

The French defecting pan has been displaced by the cheaper and more economical method of pumping the juice from the mill through one or more tubular heaters and subsequently subsiding the defecated juice in tanks of the simplest construction. But this economy of steam and simplicity of apparatus has led to the unscientific practice of adding the lime after the juice has been heated, thus directly promoting inversion during the passage of the naturally acid juice through the heater. The addition of lime to the cold juice as it leaves the mill is practiced in very few factories owing to the fact that defecation then takes place in the heater itself and the precipitated impurities adhere to the surfaces of the tubes, which require constant cleaning.

Such preliminary heating of the juice practically removes the suspended air bubbles which cause the precipitated impurities to rise as a scum; consequently, if the juice has been properly heated, little or no scum is formed, the whole of the impurities forming a sediment which slowly settles to the bottom of the tank, leaving the bulk of the liquid clear. The latter is then carefully decanted through a side cock, and the residual sediment discharged through a valve in the bottom of the tank. The sediment is received in a scum tank, where it is treated with a little lime boiled, re-subsided, and the clear liquid again decanted. The final sediment, consisting mainly of juice, is then passed through a filter.

The foregoing is the method of purification generally practiced in the West Indies to-day. Before considering recent improvements we would point out that, although defecation is a chemical treatment of the juice, this operation is still conducted by ignorant labourers without any system of chemical control. From a mechanical point of view this process may best be described as primitive, a long time being required for complete subsidation owing to the slight differences in density between the juice and the solid matters suspended therein, and necessitating a large battery of tanks, which are filled and emptied in rotation. In practical working it is, moreover, impossible to remove the finer particles of suspended impurities, so that the decanted juice is never as brilliant as juice which has been filtered. The operation of decantation requires the greatest care, but it is a common occurrence to see "muddy" juice escaping into the receiver for clear liquor; in fact, the operation is generally regulated by the appearance of sediment in the

decanted liquid; hence it follows that from every subsiding tank a small but appreciable quantity of suspended matters escape with the juice passing to the evaporator, and in the manufacture of high-grade sugar it is necessary to eliminate these by briskly boiling the juice in pans heated by steam coils. The particles are thus carried to the surface with the foam produced by the rapid evolution of steam, and are swept off into a gutter which surrounds the walls of the eliminating tank.

In place of the intermittent methods of subsidation described above, Deming has introduced his process of superheating and continuous subsidation. The cold juice is limed and pumped through a series of three tubular vessels, whereby it is heated to from 110° to 115° C., and afterwards cooled down to about 100° C. The apparatus is so designed that the juice passes through the heaters at a great velocity, thus reducing the risk of scaling and blocking the tubes with the solid matters suspended in the juice. The effect of superheating is to cause the precipitated impurities to settle more rapidly than is the case when the juice has only been momentarily boiled. The second operation consists in passing the hot defecated juice in a continuous stream through one or two settling tanks of peculiar construction, in which the precipitated impurities collect at the bottom and are withdrawn from time to time for filtration, whilst the clarified juice escapes in a continuous manner from an overflow pipe at the top of the vessel.

Filtration.—This method of separation has long been limited to the treatment of scums and sediments obtained during defecation, with the object of recovering the juice which constitutes the greater bulk of such residues. For a very long time the old Taylor bag-filter was employed for this purpose, but, besides being a clumsy and troublesome apparatus to handle, much sugar was lost in the "filter-mud" discharged from the bags. This filter has now been entirely superseded by the filter-press, in which filtration proceeds under pressure, the deposit being washed with water or steam, and discharged in a fairly dry condition; the cane industry is indebted to its rival for this valuable invention.

But whereas mechanical filtration necessitates the use of special filtering media, such as cloth, sand, &c., the cane sugar factory has always at hand a unique filtering medium which costs nothing; and it is surprising that the value of the crushed fibre, or megass, for this purpose has not been more generally appreciated. As regards the West Indies, we doubt whether a single factory has attempted filtration through megass on a practical scale.

Wright's Megass Filter was designed to treat defecated juice after decantation from the sediment, so as to render same perfectly bright before evaporation to syrup. As with other filtering media, the rapidity of filtration through megass is gradually retarded by the

accumulation of solid matters separated from the juice, so that frequent renewals of the megass are essential. For this purpose the filter is fitted with water connections for washing out the juice from the fouled megass, but experiments made with this filter in Trinidad indicate that a large volume of wash-water is required in order to avoid serious loss of sugar in the discharged megass, and the dilution of the juice by this wash-water necessitates a considerable increase in the subsequent evaporation.

In our last paper we briefly referred to the Naudet process as a method of extraction, but the novel feature of this process is the combination of extraction with defecation of the juice in the same apparatus, by utilizing the maceration cells of the battery as megass filters. The cane mill serves mainly for the production of megass, expressing only some 60 to 65% of juice from the cane. Each cell is filled in turn with the megass elevated from the mill, whilst the equivalent yield of juice is treated with lime and heated. The hot defecated juice, containing the precipitated impurities, passes into the maceration cell and is filtered through the megass from which it had, a few minutes previously, been separated by the mill. A rapid and perfect filtration is ensured by the circulating action of a centrifugal pump, which draws juice from the bottom of the cell, forces it through a heater, and returns it to the top of the same cell. By this means the bulk of the juice is separated from its impurities in from three to five minutes, and can be evaporated without further treatment. As a system of filtration this process is an ideal one, every charge of hot defecated juice being filtered through fresh megass.

During this forced filtration, which is repeated from cell to cell round the battery circuit, the two products of the cane mill are re-united in the Naudet cells, so that, when filtered juice is withdrawn from any one cell, the contained megass remains completely saturated with that liquid, the recovery of which immediately follows by means of a systematic maceration of the megass with water. This second operation constitutes the process of extraction, in which the battery is operated exactly as in the diffusion of beet slices, fully described in the last paper. In addition to filtered juice saturating the megass, this maceration also recovers from the latter that residual portion of juice which escapes extraction by milling.

It should be noted that the foregoing improvements refer exclusively to the mechanical separation of impurities rendered insoluble by the action of lime and heat. That lime is an ideal clarifying agent for cane-juice cannot be claimed; its cheapness, simplicity of application, added to the planters' respect for established custom, must account for the fact that this method of defecation remains unmodified to the present day. In making this statement, we refer to the British West Indies, other cane growing countries having availed themselves of the carbonatation process introduced by the rival industry.

Supplementary Methods.—From time to time "improved methods" of purifying saccharine juices have been the subject of patents, no less than 300 different chemicals having been recommended as substitutes for lime, without mentioning numerous attempts to purify juices electrically. Very few of these methods have been tested in cane-sugar factories, and we need only mention one or two chemicals which serve to supplement the action of lime.

Sulphurous Acid.—Defecated cane-juice has a dark reddish colour, and, after evaporation of the water, yields dark colored crystals of sugar which are used for refining purposes only. In the manufacture of high-grade sugars for immediate consumption it is therefore necessary to decolorise the juice, and, at one time, filtration over animal charcoal was adopted in both cane and beet factories for the production of a perfectly white sugar direct from the raw materials. This costly method is now exclusively confined to the sugar refinery and need not be described.

In the manufacture of the well-known "Demerara crystals" the juice is bleached by the action of sulphurous acid gas before or after defecation with lime; this agent also assists in purifying the juice by breaking up lime salts and precipitating certain impurities, and had been previously applied to beet juice in 1811.

Phosphoric acid, or its compounds with lime, is another chemical used in conjunction with lime, either for the purpose of neutralizing an excess of lime, or to promote a rapid subsidation of the lighter suspended impurities by forming with lime a heavy precipitate of insoluble tribasic phosphate of lime.

The Beet.

The expressed juice is an opaque liquid of a dark violet colour, possessing an "earthy" odour and a peculiar flavour. Whereas raw cane-juice is frequently sufficiently pure to yield a crystallisable syrup on evaporation, the juice obtained by rasping and pressing the beet contains a larger proportion of pectic impurities which gelatinize on heating and prevent crystallisation of the sugar.

1. Defecation.—The founders of the new industry naturally sought to purify beet juice by a method which had long proved effective with cane juice, and for many years the simple defecation with lime was successfully applied to the impure juices as first extracted by rasping and pressing. Not content with a borrowed method, which required a careful adjustment of the quantity of lime employed, the beet fabricants, aided by scientific experts, sought for a more efficient method of purification.

2. Sulphuric Acid.—As early as 1792, Achard succeeded in defecating the juice by the addition of a small quantity of sulphuric acid instead of lime, the free acid being neutralized with chalk before

the juice was heated. This process worked well but was little used, the simple defecation with lime being preferred.

3. Sulphurous Acid.—This agent was first recommended for purifying saccharine juices by the French chemist, Proust, in 1810, and in the following year Drapier took out the first patent for its practical application as a substitute for sulphuric acid in Achard's process. Opinions were for a long time divided as to the value of this agent and the most effective method of its application, consequently it was seldom employed until 1869, when Seyfferth proposed to introduce the acid directly into the evaporating pans during the boiling of the syrup. This process was adopted in Germany and France, but certain technical difficulties caused it to be abandoned. Sulphurous acid again came into use at a subsequent date as mentioned below.

4. Lime and Sulphuric Acid.—In 1825 a modification was introduced by Dombasle and perfected by Dubrunfaut, in which a larger and more constant proportion of lime was added to the juice, any excess being afterwards precipitated by sulphuric acid. This remained in general use until 1849, when Rousseau substituted carbonic acid for removing the excess of lime.

5. Single Carbonatation.—Rousseau's method, first proposed by Kuhlmann in 1833, consisted in defecating the juice by means of a slight excess of lime, decanting the clear liquid, and filtering the sediment. The clear alkaline juice thus obtained contained lime in solution and was treated with carbonic acid gas which precipitates lime as insoluble carbonate of lime or chalk. Any excess of the volatile gas was removed by boiling the liquid, which was then filtered. This process was equally applicable to juices of very different degrees of purity and possessed the additional advantage that much of the colour was absorbed from the juice and retained in the precipitated chalk whereas, after simple defecation with lime, the purified juice was always strongly coloured and yielded an inferior quality of sugar. The beet fabricants had hitherto adopted the costly system of filtration through animal charcoal, the discolorising power of which had long been utilized in refineries. Rousseau's process was therefore eagerly adopted when it was found to economise some 30 % of the charcoal formerly required.

6. Double Carbonatation.—Finally, in 1859, M. M. Perier and Possoz greatly improved the method of Rousseau by a system of double carbonatation which has since been adopted in every sucrerie. We may remark, in passing, that this process paved the way for the introduction of the diffusion method of extraction by Robert in 1860. When Dombasle first put forward his diffusion process in 1830, the only method then known for purifying the juice was the simple defecation with lime, but this entirely failed when applied to the purer juices obtained by diffusion. The latter process, as already fully explained, consists of a selective extraction of the crystallisable

constituents (including the sugar) from the cellular vessels composing the beet, the noncrystallisable impurities (including albumen, pectine, etc.,) being retained in the spent beet slices. Defecation of such juices produces a very slight precipitation of impurities which cannot be separated, so that Dombasle's valuable suggestion remained impractical for thirty years.

In the carbonatation method of purifying beet juice we have yet another illustration of the practical value of science to the manufacturer which merits a somewhat detailed description.

In the simple defecation with lime, as first applied to the cane, the proportion of lime added should be just sufficient to combine with the impurities dissolved in the juice forming with them insoluble lime compounds, which are subsequently removed as sediment, whilst the clear juice contains little or no lime in solution. The success of this process demands a careful adjustment of the quantity of lime employed to suit the variable quality of the juice treated; an insufficient or an excessive use of lime being alike objectionable.

This difficulty is removed in the carbonation process by adding an ample excess of lime for all qualities of juice, and removing the excess of this alkali by means of carbonic acid.

In both methods it is necessary to avoid any considerable excess of lime, otherwise the juice is very difficult to work up into sugar. Moreover, lime combines directly with sugar to form sucrates of lime, of which there are three distinct varieties, containing respectively one, two, and three equivalents of lime in chemical combination with one equivalent of sugar; the two former being soluble, and the latter insoluble, in water. On heating clear juice containing soluble sucrates of lime, the latter are transformed into the insoluble variety which is precipitated as a solid and renders the liquid cloudy; after cooling, the precipitate re-dissolves, and the liquid becomes clear. Hence we learn that when juice is defecated with a considerable excess of lime, and filtered hot, a portion of the sugar remains in the filter as solid sucrate of lime, to be subsequently thrown away as refuse.

The sucrates of lime are unstable compounds, readily decomposed by acids, so that the addition of sulphuric acid in Dubrunfaut's process, or of carbonic acid in Rousseau's method, causes an instantaneous precipitation of lime, in the former case, as sulphate of lime, or gypsum, and in the latter, as carbonate of lime, or chalk. In both cases the sugar is set free from its former combination with lime, and remains in solution in the juice.

Although Rousseau's process was a distinct advance on the old defecation with lime alone, it required the greatest precautions to ensure good results. If the saturation of the excess of lime by the gas be carried too far, a part of the precipitated chalk re-dissolves, restoring to the juice the colouring matter and other impurities

previously separated. If, on the other hand, the saturation is incomplete, the juice remains alkaline, coloured, and is difficult to work up.

M.M. Perier and Possoz avoided these difficulties by performing the operation in two stages, by which means the saturation with carbonic acid is interrupted before the critical stage is reached and the juice decanted or filtered from the mixed precipitate of chalk, colouring matter, and other organic impurities. The clear but alkaline juice enters a second vessel in which it is treated with the gas until the saturation is complete without the slightest risk of returning impurities to the juice which was the defect of the single carbonatation method.

The successful adoption of carbonatation completely revolutionized the former methods of treating the juice by dispensing with the costly process of filtration through animal charcoal, regarded for 20 years as absolutely indispensable for the proper purification of beet juice.

Within the limits of this paper we are unable to describe the mechanical appliances used in carbonatation, but, as the essential feature is the separation of the precipitates without loss of sugar, it is of interest to state that this valuable method could not have come to light without the invention of the modern filter-press, as brought to perfection by Hoekner, Roetger, Durieux, and others at a time when the new process was being developed.

The carbonic acid gas is produced by burning limestone in kilns, the residue furnishing the supply of quicklime required in the process.

SUPPLEMENTARY METHODS.—*Baryta* is an alkali closely resembling lime, but is even more effective as a defecating agent, although its higher cost has hitherto prevented its substitution for the latter. As an auxiliary agent, baryta is frequently added to the juice passing to the second carbonatation, and precipitates those impurities which lime fails to remove.

SULPHUROUS ACID.—Since the adoption of carbonatation and the consequent disuse of char filters, chemists have sought to complete the purification of the juice by means of a chemical agent possessing the bleaching property of char, but less costly in application. Sulphurous acid, so long discredited, is now recognised as a valuable agent in the modern sucrerie, and has been applied to the juice before or after carbonatation, as also to the concentrated syrup. In the modern practice, introduced by Weisberg, the gas is applied to the filtered alkaline juice, obtained by the first carbonatation, until the alkalinity is reduced to a certain point. Milk of lime is then added, and the second carbonatation proceeded with, after which the juice is briskly boiled before the second filtration.

(To be continued.)

SUGAR CROPS OF THE WORLD.

(After Willett & Gray.)

In the following table we have aimed to include the entire sugar production of all the countries of the world, including those crops which have heretofore been ignored in statistics. These figures include local consumption of home production wherever known.

Willett & Gray's estimates of cane sugar crops, July 14th, 1904:—

	1903-4.	1902-03.	1901-02.	1900-01.
United States—Louisiana	215,000	300,000	321,676	270,338
Porto Rico	126,000	85,000	85,000	80,000
Hawaiian Islands	343,000	391,062	317,509	321,462
Cuba, *crop*	1,000,000	998,878	850,181	635,856
British West Indies—Trinidad, *exports*	49,000	45,000	51,077	52,673
Barbados, *exports*	70,000	33,000	43,750	55,360
Jamaica, *exports*	13,058	18,772	15,843	17,059
Antigua and St. Kitts	19,000	18,000	19,000	21,579
French West Indies—Martinique, *exports*	25,000	29,035	34,942	39,750
Guadeloupe	40,000	38,000	41,000	39,000
Danish West Indies—St. Croix	13,000	13,000	13,000	13,000
Haiti and San Domingo	45,000	45,000	45,000	45,000
Lesser Antilles, not named above	13,000	12,000	15,000	15,000
Mexico, *crop*	120,000	112,679	103,110	95,000
Central America—Guatemala, *crop*	10,000	10,000	10,000	9,000
San Salvador, *crop*	5,000	5,000	5,000	5,000
Nicaragua, *crop*	4,000	4,500	4,500	3,500
Costa Rica, *crop*	4,000	4,000	4,000	4,000
South America—				
British Guiana (Demerara) *exports*	125,000	121,570	123,967	84,559
Dutch Guiana (Surinam), *crop*	13,000	13,046	12,750	13,000
Venezuela	3,000	3,000	3,000	3,000
Peru, *crop*	140,000	140,000	138,000	135,000
Argentine Republic, *crop*	140,719	130,000	135,000	114,252
Brazil, *crop*	227,000	187,500	349,088	308,011
Total in America	2,762,777	2,758,042	2,741,393	2,380,399
Asia—				
British India, *exports*	15,000	15,000	15,000	15,000
Siam (con'sn 30,000 tons, mostly imported).	....	....	....	....
Java, *crop*	885,561	842,812	767,130	709,928
Japan (cons'n 170,000 tons, mostly imported)	....	....	....	....
Philippine Islands, *exports*	100,000	90,000	78,637	55,400
China (cons'n large, mostly imported)	....	....	....	....
Total in Asia	1,000,561	947,812	860,767	780,328
Australia and Polynesia—				
Queensland	94,000	76,626	120,858	92,554
New South Wales	20,000	21,000	18,000	19,000
Fiji Islands, *exports*	50,000	35,500	31,000	33,000
Total in Australia and Polynesia	164,000	133,126	169,858	144,554
Africa—Egypt, *crop*	90,000	87,500	98,000	94,880
Mauritius	205,000	150,349	147,828	175,267
Reunion	25,000	39,624	33,098	42,631
Total in Africa	320,000	277,473	278,926	312,778
Europe—Spain	28,000	28,000	28,000	28,000
Total cane sugar production (W. & G.)	4,275,338	4,144,453	4,078,944	3,646,059
Europe Beet sugar production (F. O. Licht.)	5,850,000	5,552,167	6,760,356	5,990,080
United States Beet sugar production (W. & G.)	208,135	195,463	163,126	76,859
Grand total Cane and Beet sugar—Tons	10,333,473	9,892,083	11,002,426	9,712,998
Estimated increase in the world's production	441,390	....	....	....

DIFFERENT HEATING SYSTEMS IN SUGAR MANUFACTURE.

By A. Sillinger.

The principal burden in the working expenses of a raw sugar factory and sugar refinery is undoubtedly the coal bill. It is, therefore, the object of the expert, dealing in this branch, to obtain as favourable a result as possible by a systematic control in the boiler house through the economical use of fuel and a rational employment of the steam needed in the various kinds of heating systems.

The extent to which the different forms of steam heating apparatus supply present demands forms the object of the following notes.

It is obvious that in the heating of a liquid the heat is communicated from its source to the liquid through the medium of a partition wall.

Saturated steam serves as a source of heat for the warming up, steaming and boiling to grain of juices, and transfers its heat to the juice through a metallic partition according to the formula $Q = F.D.k$ in which $Q =$ quantity of heat transferred; $F =$ area of transmission surface of the heat; $D =$ difference between the temperatures of the steam and the liquid to be heated (*i.e.* the fall in temperature); $k =$ coefficient of heat transmission. Suppose $F = 1$ square metre, $D = 1°$ C., then it is clear $k = Q$, and thus we can estimate the transmission coefficient for that amount of heat which is furnished by the steam in the unit of time (hours, minutes, seconds) through a partition having a surface of 1 square metre.

The coefficient of transmission is not constant; it depends in the first instance on the coefficient of thermal conductivity possessed by the different materials which go to form the heating system; further, on the shape and thickness of side of the apparatus and finally on the extent to which the temperature falls.

The coefficient of thermal conductivity is defined as the amount of heat which passes in a unit of time from one side to the other of a cubic metre when the difference in temperature between the sides amounts to 1° C. Consequently it also varies with different substances. Silver, for example, gives 100, copper 72, brass 25 to 28, iron 16, and lime salts, which form incrustations on the heating tubes, 0·5 to 1 calories. For a given thickness of partition the transmission coefficient is proportional to the coefficient of thermal conductivity. Since the transference of heat depends on the difference in temperature between the heating steam and the juice to be treated, the coefficient of transmission increases in proportion to this difference in temperature and to the pressure of the steam. Again, the fall in temperature depends on the expansion of the steam and on the concentration and viscosity of the juice. As the steam is cooled by expansion, the difference in temperature becomes less, and the coefficient of transmission falls in the same proportion.

With increasing concentration the specific heat of the liquid increases, while the fall in temperature and thereby also the coefficient of transmission decrease. These points were established by experiments carried out by Mollier.

The development of steam can take place in two different ways. Either bubbles of steam are produced on the upper surface of a liquid at a somewhat higher temperature than the freezing point, in such a manner that the individual molecules under outside influence, such as a draught of air, separate from the agitated surface of the liquid in the form of steam and diffuse in the atmosphere—"the liquid evaporates"; or else they are formed within the liquid itself and escape more or less violently from the surface of the liquid—boiling begins. According as the steam bubbles produced underneath the surface of the liquid stand in relation to the barometric pressure and the juice column, they require a certain pressure to overcome them; this increases from below. Through this pressure the steam produced becomes saturated and absorbs no more heat, so that care must be taken for its diversion or else the transference of heat will be interrupted. Either this arises naturally, since the steam, being specifically lighter, rises and carries the juice with it in its upward motion whereby a colder portion takes the latter's place, in other words a natural circulation exists, such as is necessary for the transference of heat; or else an artificial movement by means of stirring apparatus is carried out if the concentration increases.

The saturated steam, on yielding its heat to the liquid, condenses and cools off. It is therefore needful to drain off the condensation water rapidly so as to avoid the temperature of the subsequent steam being reduced and its contact with the whole heating surface becoming disturbed. With these considerations it is therefore evident that a steam heating system shall possess the following characteristics:—

1. It must be made of good heat conducting material of which the thickness of partition shall be as small as possible.

2. The heating surface shall be as large as possible and must have full contact, on the one side with the heating steam, and on the other with the liquid to be heated.

3. The difference in temperature between the steam and the liquid to be warmed, and the pressure and flow of the steam must where possible be considerable.

4. The circulation of the juice, whether artificially or naturally produced, must be carried on vigorously.

5. Rapid draining off of the ammonia and condensation water is necessary.

6. Low juice column and large surface of juice desirable.

7. The greatest transfer of heat shall take place in the lowest strata of the juice.

In these respects we will now see how far the heating systems existing at the present day in sugar manufacture fulfil these requirements.

1. The Heating Tubes.

The spiral heating tubes are generally formed from copper pipes of from 80 to 100 mm. dia., finished in a series of coils and inserted into the vessel to hold the liquid to be heated up. The steam flows from top to bottom, transfers its heat to the fluid through the intervening medium and then condenses.

In the lower coils of the pipe, where essentially the greatest transfer of heat should take place, we find the condensation water collecting; the latter not only cools the heating surface it comes in contact with, but also throttles the flow of steam whereby the liquid lying round the lower coils gets less heat, the circulation is rendered less vigorous and incrustation is encouraged. The difference between the upper and lower resistances varies according to the height of the spiral column, and in the former instance is practically nil. Here the escaping steam bubbles carry the juice along with them and under high steam pressure their action is so violent that the liquid in the vessel rises and care must be taken to provide it with ample room to so ascend.

The tubes can only be heated with live or return steam since they have no arrangement for drawing off the ammonia.

From the force of the steam, the tubes are easily rendered leaky, while repairs are impossible during the working operations.

Yet in spite of their faults these heating tubes find abundant employment for they are easily and cheaply made, and can be adapted to fit any shape of vessel.

When the heating tubes are built pretty high so as to obtain a large heating surface, and have all to be covered with juice the relation of the juice surface to the height of the juice column gets too small, in consequence of which the circulation of the juice is considerably reduced.

II. Horizontal Tube-Heating Apparatus.

Acting on the knowledge that a rapid steaming can only be accomplished with a large steaming area and a low juice column, Rillieux, Lexa, Jelinek, and others built closed horizontal cylinders or box shaped vessels with a heating system consisting of a number of narrow tubes of thin section, somewhat inclined to the horizontal and with parellel axes; these passed into a chamber formed beyond the principal partition, from which the steam was led off by different passages. The condensation water was drained off at the bottom of this chamber and the gases liberated at the top, so that this heating system was applicable for juice vapours as well.

In spite of the favourable form of the apparatus, possessing as it did large surfaces and a low juice column, it was subject to many a

breakdown. The employment of long narrow tubes entails their being curved round one another, with the result that condensation water lies in the bends and hampers the flow of steam.

This drawback is likewise met with in the upward flow of the steam on its way from the chamber into the pipes since the condensation water is carried along with it and the steam thereby gets cooled.

The comparatively large heating surface of the chamber which is inactive tends also to chill the steam.

Furthermore the tubes suffer from the steam pressure to such an extent that they are often cut through at the stay-plates. A repair during the progress of work is out of question, and afterwards the replacing of a damaged pipe is a heavy job and involves considerable loss of time.

As in the spiral pipes, so here also the circulation of the juice is hindered through the juice column and the friction on the under surfaces of the steam pipes, and when the network of tubes is fairly thick the warm ascending liquid stream does not allow the colder particles to descend, so that the circulation in the lower strata ceases.

A more vigorous circulation can only take place in the topmost portions of the juice and these must be provided with plenty of room for moving in, as is the case in vessels with spiral piping. An insufficient circulation likewise results in incrustations on the upper surfaces of the pipes, and these cannot be removed while work is in progress.

To obtain a greater circulation the so-called circulators were introduced. These were vertical vessels with fixed heating and a stream of juice flowing from beneath. They however failed to serve their purpose. As physical laws would show, a colder and specifically heavier liquid does not allow a warmer and specifically lighter one above it when of the same chemical composition, to descend below it; hence no circulation can ensue.

III. Vertical Heating Apparatus.

Robert employed a vertical heating vessel in the apparatus named after him; it was a vertical cylinder, with a double bottom and corresponding openings; short brass tubes were fitted inside. The space between the heating tubes and the double bottom formed the heating chamber. From the lower bottom two or more pipes led off the condensation water, and from the upper part the gases escaped.

The juices circulated through the pipes, while the latter were surrounded by the steam; the condensation water drained down the outer surface of the pipes and collected at the bottom.

If the drainpipes do not suffice to let off rapidly the condensation water from the furthest parts, the whole heating surface of the lower chamber is covered with this water and is rendered useless.

On boiling the juice, vapours arise and come into contact with the upper partition, whereupon, as in the draining off of the condensation water in the lower chamber, the heating influence of the steam is reduced.

On heating the juices in the pipes the steam-bubbles developed rise vigorously upwards, jolting the liquid along with them; but the latter keeps falling back, to be thrown upwards again and again.

It is self-evident that to surmount a higher juice column a greater heating energy is needed; so that, therefore, in the lowest portions where the greatest transfer of heat should take place, stagnation reigns.

Piedboet introduced a large pipe in the middle of the heating surface with the object of allowing the cooler portions of the liquid to descend to the bottom and thus circulate the juice.

This circulation, however, only occurs in the immediate neighbourhood of this large pipe and has practically no influence on the juice in the more distant pipes.

With the further object of encouraging a circulation, little slips of wood were inserted in the middle of the pipes with the object of lessening the juice column and increasing the circulation. As these got loose or easily broken they entirely failed in their object.

These vertical heating apparatuses have the advantage over the horizontal type in that the incrustations are here, not on the outside of the tubes but inside; consequently they are easy of access for cleaning purposes during progress of work without any considerable loss of time, and damaged tubes can be eliminated by simply closing up both ends.

IV. Other Heating Systems.

It is easily seen that in the above-mentioned heating systems a rational cooking and steaming process has not been attained.

W. Greiner endeavoured to prevent the chilling of the steam by his system which consisted of short bent tubes, overlaying one another, with a single entrance for the steam; the condensation water was led off independently from each pipe in one direction.

Märky, Bromovsky, and Schulz followed this plan with a heating apparatus consisting of vertically curved tubes of U-shape, in which the condensation water dripping from all parts to the bottom bend was led off from there by a common pipe. As, however, both these systems cannot be heated with juice vapours, are difficult of access, and therefore are uncontrollable in the event of their getting out of order, they have consequently achieved no appreciable success.

An improved steam heating was thereupon obtained by injecting the juices against the heating tubes whereby the heating surface was artificially increased; this principle has been used in the superposed steam-heating apparatus and with rotating heating systems.

During the last few years the circulation heating chambers of W. Witkowicz have been gradually introduced into the sugar industry. The construction and installation of these in the different juice receptacles give an ideal circulation and steam heating.

The fundamental principle of the construction of this heating chamber consists in the use of pipes crossing each other at a high angle, their ends being directed to the opposite walls of a hermetically-sealed vessel, which is sunk in the liquid about to be warmed. The heating steam is introduced into the interior of the chamber, and heats the liquid present in the pipes.

These heating chambers are installed in the liquid in such a way that they rest on a corner of the wrought-iron prism, where a support for leading off the condensation water is likewise fixed. In this way the pipes crossing each other are placed at an angle of 45°. In the upper corner of the prism there is a support for the escape of gases. The support for the injection of steam is in the middle of the front wall. The heating chamber is provided with a vessel for the reception of the condensation water.

The pipes are not made longer than 850 Mm., and these are the ordinary Mannesmann steel pipes, with a metal thickness of 1½ to 2 Mm., and of different diameters for different purposes. So, for example, for warming the diffusion juices the diameter of the pipes is 29 to 40·5 Mm.; for warming the saturated thin and thick syrups, 22 to 32 Mm.; for steam heating apparatus, 20 to 29 Mm.; for syrup boiling and crystallisation of by-products, 40 to 50 Mm.; for boiling to grain of first product, 69 to 72 Mm. These circulation heating chambers give the following results of co-efficients of transmission:—

For Diffusion Juice.—In the case of direct steam heating, 12 to 18; of heating with exhaust steam, 10 to 14.

For Scums.—With direct steam, 14 to 20; exhaust steam, 10 to 16.

For thin and concentrated syrups.—With direct steam, 18 to 25; with exhaust steam, 15 to 20.

For boiling down juice, 45 to 70; 1st chamber, 40 to 60; 2nd chamber, 35 to 40; 3rd chamber, 30 to 45; 4th chamber, 28 to 40.

For first product vacuum pan, syrup boiler and crystallisers, 25 to 35.

According to the fall of temperature, the lower, higher, or average figure is reckoned.

The circulation heating chambers can easily be fixed into any receptacle, also in a pipe, indeed, in every place where it is a question of increasing the heating surface in a small space.

The typical installation of the heating chamber necessitates a quick drawing off of the condensation water, reducing its contact with the heating surface and the steam to a minimum. As the rapid drawing off of ammonia is provided for in the upper part of the heating chamber, the heating steam remains in close contact with the whole heating surface.

The setting up of the heating chamber and the typical installations of the network of pipes result in the fact that the warmed liquid cannot stream back, but is thrown out of the pipes in such a way that it flows downwards, towards the ground, describing a parabolic curve.

Through the uninterrupted movement of the liquid in the pipes, an action is set up in the lower orifices of the pipes, whereby the liquid falling to the ground is taken up again and back on the other side in the same way, so that an uninterrupted circulation is set up in the form of a horizontal 8, which in high temperatures is so pronounced that it may be followed with the eye. Even with the lowest temperatures, the circulation is satisfactory.

In consequence of this, the pipes are hardly ever, if at all, misplaced, and owing to their accessibility they can easily be cleaned during the process of working.

The advantage of the circulation chambers appears in the higher coefficients of transmission, as compared with the previously described heating systems.

If, for instance, in a horizontal steam heating apparatus, of 240 square metres heating surface, you insert a Witkowicz heating chamber of 24 square metres, this will correspond to the effect of a steam heating apparatus of 320 square metres.

The circulation heating chambers may be used advantageously at different stages of manufacture. As an example of their efficiency, I may say that in the sugar factory at Auschitz, for the warming of the scums after the first saturation, a chamber of 10 square metres heating surface sufficed to warm a quantity of 8,000 metric cwts. with direct steam (162°) from 75° to 95° C. The circulation was so violent that no incrustation took place, and therefore the cleaning of the pipes during the whole of the campaign was unnecessary. By fixing these heating chambers in already existing steam heating and boiling apparata, we can considerably increase their heating surface and thus augment the circulation of the syrups.

So in Auschitz we increased the heating surface of an old vertical first product vacuum pan from 20 sq. metres heating surface, through the fixing up of two Witkowicz heating chambers, to 35 sq. metres. The boiling of the thick syrup to string-proof was carried out with these two chambers, and the boiling lasted only half the time employed formerly. The masse-cuite boiled to 96% dry substance flowed freely out of the pipes of a diameter of 72 mm.

With steam heating and water apparata fitted with heating chambers, all dangers from inactive parts of the chambers are avoided, as well as the costly renewing year by year of the heating pipes.

The steam-heating effect of this apparatus amounts to 100 kilogs. of water per one sq. metre of heating surface for one hour.

From the foregoing observations it will be seen that circulation heating chambers mark an important progress in the method of steam using. The practical heating effect is brought considerably closer to the theoretical, and the result appears in the technical tout-ensemble.—*(Oesterreich-Ungarische Zeitschrift.)*

CHEMICAL CONTROL IN USE IN THE JAVA SUGAR FACTORIES.*

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PART I.—DAILY REPORT.

Analytical Methods.

1. Cane.

1. Laboratory Samples.

Sampling.—From every cart-load of cane entering the factory, retain two canes and put them in a cool place protected from wind and rain. Early in the morning the canes are counted and one taken out from every ten, in which sample determine:

Fibre.—Take from the sample mentioned above, without picking, as many canes as weigh about 25 kilogrammes, cut them in pieces, weigh and crush them in a small test mill, extracting about 72% juice from 100 parts of cane. Weigh the bagasse resulting from this operation, chop it into coarse pieces, mix thoroughly and crush part of the sample to a fine powder. Extract 20 grammes of this powder in a Soxhlet extraction apparatus with alcohol, dry the extracted fibre, weigh it and calculate the weight on 100 parts of cane. This estimation is to be made once a day.

Example.

	Kilogrammes.
Weight of cane crushed	25
Weight of bagasse	6
Weight of juice extracted	19
Fibre content of the bagasse	43·75%

Then the fibre content of the cane $= \frac{6 \times 43{\cdot}75}{25} = 10{\cdot}5\%$

2. Factory Samples.

Sampling.—From every cartload of cane entering the factory, keep apart one or two bundles, and pile up the bundles of each field on their own special heap so that every heap contains the canes cut that day from its own field. Once a day these heaps are crushed separately by the factory mill, and the first mill-juice continually sampled by taking small quantities of the juice from the gutter with a small measure glass and pouring it into a bottle or kerosine oil tin.

In the samples determine degrees Brix, sucrose, and quotient of purity. The available sugar is calculated for 100 parts of juice after the formula : Quotient × sucrose of first mill juice ÷ 100 ; and for 100 parts of cane after the formula : 0·8 × quotient × sucrose of first mill juice ÷ 100. In such a way no absolutely accurate figures are obtained, but they are mutually comparable. At the end of the grinding season the real production of each field can be found by multiplying the thus obtained approximate figures with the factor representing the proportion between the sugar actually produced over the whole estate, and the sugar calculated from all the fields in the above-mentioned way.

3. Field Samples.

Determination of the point of maturity of the cane field.—The cane fields are divided into plots which have been planted and manured at the same time and in the same way. After 10 months of growth take from every plot 40 normally grown cane plants, mark and number them. Every fortnight one cane stalk is cut from each one of the stools and the bundle carried to the laboratory, where the green top-end is removed and the canes are measured, weighed, and crushed in a small test mill, after which the juice is analysed. The analytical data from each analysis of the same plot are entered down so that an increase of sucrose content, or purity, or a falling in them can be detected at once. As soon as the sucrose content or the purity cease to augment, the cane of the plot under review has attained its point of maturity and should be cut in order to prevent deterioration by too long standing in the field.

The results are put down in the following table, in which the percentage of diseased or worm-eaten canes is also recorded :—

Number or name of the field ....

Date of planting.	Date of analysis.	Number of canes.	Length of the cane.	Weight of the cane.	% attacked by borers.	% attacked by diseases.	Composition of the juice.			% juice extracted.
							Brix.	Sucrose.	Quotient.	

Fallen canes are not analysed.

2. Bagasse.

Sampling.—The bagasse is sampled at the last mill by taking every now and then a small quantity of bagasse and throwing it immediately into a basket, covered with a lid. Once every hour this sample is brought to the laboratory, mixed, chopped rapidly, and of this bagasse we weigh without delay for

Determination of the sucrose.—20 grammes; these are put in a tared tin cylinder, weighed again and moistened with 300 grammes of water and 3 c.cm. of subacetate of lead, after which the mixture is heated and boiled for ten minutes. In order to promote clearness of the liquid 5 drops of a 10% solution of carbonate of soda are added, the mixture is then cooled down to the ordinary temperature, afterwards weighed again and the weight noted; next the liquid is filtered and polarised in a 400 mm. tube.

The sucrose content is read in a table in the consulting of which we must keep in mind that the fibre content of the bagasse is taken to be 45% and the weight of both bagasse and liquid to be equal to their volume (*i.e.*, that their specific gravity = 1). The total amount of liquid is therefore not only the difference between the weight of the cylinder + bagasse, and that of the cylinder + bagasse and the water after boiling and cooling, but augmented with the juice already present in the bagasse, viz., 55% of 20 grammes or 11 grammes.

	Gr.
Tared cylinder	350
20 grammes of bagasse	20
	370
	Gr.
Cylinder + bagasse + water and chemicals after cooling	657
	370
	287

The amount of liquid thus amounts to 287 + 11 = 298 grammes.

Suppose the polariscopic reading be 2·2 then according to the table the sucrose content of the bagasse would be 4·26%.

Determination of the dry substance.—20 grammes of the chopped bagasse are weighed, transferred to a tared shallow tin dish of $1\frac{1}{2}$ sq. dm. surface and dried for 5 hours at 100° C. or, if the bagasse is dried by steam, at 95° C. to constant weight. When by accident the temperature has risen too high (visible in the yellow or brownish tinge of the dried material) the result of that analysis should not be taken into account when calculating the average dry substance.

Determination of the Fibre.—The fibre content is calculated once a day from the average content of dry substance and sucrose of the bagasse and the quotient of the last mill juice. In this case we suppose the quotient of the juice in the bagasse to be equal to that of the last mill juice, a supposition which does not depart much from the truth.

Example.

Dry substance in bagasse	54·0
Sucrose in bagasse	4·30
Quotient of last mill juice	73·

then the soluble dry substance of the bagasse $= 4{\cdot}3 \times \frac{100}{73} = 5{\cdot}9\%$ and the fibre or insoluble dry substance $= 54{\cdot}4 - 5{\cdot}9 = 48{\cdot}50$.

If one wants to determine in a direct way the fibre content of the bagasse a fixed quantity is weighed from every sample and these quantities are collected in a stoppered bottle; once a day the contents are mixed, 10 grammes are extracted with alcohol in a Sexhlet extraction apparatus and the dried fibre is weighed after being perfectly dried.

The determination of sucrose is made every hour, the moisture is determined if possible once every two hours and the average is calculated from the results of those determinations once every 24 hours.

3. First and Last Mill Juice.

Sampling.—During grinding small quantities of juices are continually taken from the gutters with a 10 c.cm. measure and poured into tins, provided with a funnel of wire gauze; every hour the tins are brought to the laboratory.

Preparation of the Sample.—The juice is well mixed and next filtered through a funnel of very fine metallic gauze into a copper or tin cylinder provided with a discharge pipe about three inches from the bottom, which pipe can be closed with a rubber tube and a cock. The juice is left in the cylinder for half an hour so as to allow the mud to subside and the scum to rise; after that time the clear juice is ready for analysis and may be drawn off by opening the cock.

Determination of degrees Brix.—Plunge a Brix Hydrometer, verified at 17·5° C into the juice, read the temperature and the scale of the hydrometer and correct the latter from the reading of the thermometer. Measure 100 c.cm. of the juice and pour them into a stoppered bottle in which a quantity of corrosive sublimate has been thrown equivalent to 0·25 grammes for every litre of juice expected.

Once every 12 hours the contents of the bottle, representing the average of the 12 subsequent hourly samples are well shaken and mixed, next the degrees Brix are determined again as a check on the previous determinations in the hourly samples, subtracting from the corrected Brix degrees 0·05 as a correction for the increase in specific gravity occasioned by the addition of the corrosive sublimate; a $\frac{100}{110}$ flask is filled to the lowest mark with the juice, 3 c.cm. of subacetate of lead added; we complete with water to the upper mark, shake, filter, and polarise in the 200 mm. tube. The sucrose content can be calculated from the polariscopical readings and the uncorrected average Brix by the well-known tables of Schmitz, or after the formula: $S = \frac{\text{pol.} \times 26{\cdot}048 \times 1{\cdot}1}{200 \times \text{sp. gr.}}$

Quotient of Purity.—Divide the sucrose by the degrees Brix and multiply by 100.

4. Mixed Juice.

Sampling.—Take from each filled measuring tank an always identical quantity which ought to be so much that one hour's work

yields enough for analysis. The preparation of the sample, the determination of Brix, sucrose and quotient are exactly as just described for "first mill juice." It is to be recommended in order to avoid sourness and fermentation in the samples of mixed juice, which remain without a disinfectant, to use two sets of tins and measures, which are well cleaned and dried alternately.

Determination of the glucose or reducing sugar.—Although the determination of the glucose is not strictly necessary for the control, it is advisable to estimate the amount of this constituent in the mixed juice and in the syrup with a view to detect an eventual inversion or sourness of the juice between those stages.

Measure from each sample of mixed juice, prepared for the polariscopical test, 25 c.cm. and pour them into a stoppered bottle; next analyse the contents once every 24 hours. To this end 20 c.cm. of the juice are pipetted in a 100 c.cm. flask, one precipitates the surplus lead with a solution containing 5% of sulphate and 5% of carbonate of soda, fills up with water to the mark, shakes, filters into a burette and the resultant is used for the precipitation of 10 c.cm. of Fehling's test solution of half strength (so called half normal Fehling's solution). The 10 c.cm. of that half normal solution are pipetted in a Erlemeyer flask, 40 c.cm. of water is added as well as a few drops of strong soda lye and the whole is boiled on a methylated spirit or Bunsen lamp. Run into the hot solution from the prepared juice from the burette a little less than is thought necessary, boil again and keep boiling during one minute, allow the red precipitate to settle and observe the coloration of the clear liquid. If it is still blue, a little more of the juice is to be added, if colourless then the proper point is reached, but if the liquid is yellow the test should be repeated with a smaller quantity of the juice. If the discoloration is only obtained after two or more additions of juice there is danger that a little of the red oxydule has become redissolved again and that therefore the result will be a too low figure for the glucose. In order to avoid this the experiment should be repeated with so much juice that the total precipitation is obtained after (at the most) three additions of juice. When the red precipitate does not settle quickly, add about 10 c.cm. of a solution of gypsum and boil again.

The total disappearance of the blue colour of the supernatant liquid can be obtained by experienced operators by simply looking through it. At any rate it may be controlled by taking out a drop of that liquid with a glass rod and mixing it with a drop of solution of ferrocyanate of potash lying on a porcelain plate and acidulated with acetic acid just before the addition of the drop to be tested. A brown coloration detects the presence of dissolved copper in the liquid and shows that in the next test more of the juice should be used.

Glucose ratio.—Divide 100 × the glucose by the sucrose content.

5. Clarified Juice and Filter Press Juice.

The analysis of these juices is made in the cooled down samples in the same way as described under "Mixed Juice."

6. Filter Press Cakes.

Sampling.—After the filter press cake is discharged, take samples from them with a sample iron, knead them well in a mortar, and analyse.

Sucrose content.—Taking into account the insoluble part of the substance, weigh 24·7 grammes, rub it in a mortar with little water to a smooth paste, dilute it gradually with more water and run the homogenous, thin mass, without loss, into a 100 c.cm. flask, add 2 c.cm. of subacetate of lead, fill up to the mark, mix, filter, and polarise in a 200 mm. tube; the polariscopical reading represents percentage of sucrose in the filter press cake.

For factories working with the carbonatation process it is necessary to add 8 grammes of crystallised calcium nitrate to the filter press cake before rubbing it with water in order to break up the eventually present saccharate of lime and dissolve the sucrose from that combination. This estimation is performed once every 12 hours.

7. Syrup.

Sampling.—Take from each settling tank an equal quantity of syrup, pour it into a stoppered bottle, and analyse the well mixed sample once every 12 hours. After use the bottle should be washed with concentrated soda lye and afterwards with water, next the bottle is put aside in order to dry, whilst another bottle is used for the next sample. If the bottles are cleansed in this way it is unnecessary to add disinfectants to the syrup.

Determination of Sucrose and degrees Brix.—It is advisable to make the conditions in which the determination of the degrees Brix of the syrup is performed equal to those prevailing at the analysis of the mixed juice, in order to eliminate all changes occasioned by the expansion or contraction on dilution or concentration. Therefore the syrups, masse-cuites, and molasses are diluted to the concentration of the cane juice previous to their being examined with the Brix hydrometer.

In the case of syrup the dilution is from 1 to 3, so one part of syrup is diluted with two parts (in weight) of water and analysed as the first mill juice. The figures for Brix and sucrose are multiplied by 3 (the degrees Brix after correction for the temperature).

Glucose.—Is determined as described under "mixed juice," the glucose content is also found by multiplication by 3.

Alkalinity.—If necessary the alkalinity of the filter juice, clarified juice and syrup can be estimated by titration with $\frac{1}{28}$ normal acid, of which 1 c.cm. neutralises 1 milligramme of lime. Take 100 c.cm. of juice and add the standard solution from a burette, with red and blue litmus paper as an indicator. The syrup is tested after the dilution.

8. Masse-Cuites.

Sampling.—The sample of first masse-cuite is taken from each pan individually during the strike and that of second masse-cuites from the basins or crystallisers just after striking.

The samples from each lot are mixed and analysed once a day.

Determination of degrees Brix and sucrose.—The degrees Brix and the sucrose are estimated as mentioned sub "Syrup" with that difference that the dilution is 5 times now. One part of masse-cuite is dissolved in 4 parts (by weight) of water and the figures obtained are of course multiplied by 5.

In view of the inferior quotient of many of the masse-cuites the amount of subacetate of lead necessary for proper clarification is larger and may be put down like this :—

			c.cm.
For masse-cuites of		$\pm$ 90	3
,,	,,	$\pm$ 80	5
,,	,,	$\pm$ 70	6
,,	,,	$\pm$ 60	8
,,	,,	$\pm$ 50	9
,,	,,	$\pm$ 40	10

9. First Molasses.

Sampling.—For every masse-cuite one sample is taken from the discharge gutter of the centrifugals and therein determine the quotient of purity. To this end the molasses is diluted with water to the concentration of 15—18 Brix, a $\frac{100}{110}$ flask is filled with this solution to the lower mark, the necessary amount of subacetate of lead is added, filled up to the highest mark, well shaken, filtered and polarised. When the liquid is too much coloured to be polarised in the 200 mm. tube, use the 100 mm. one and multiply the reading by two.

For molasses of $\pm$ 60 purity use 8 c.cm. of subacetate of lead.
,, ,, $\pm$ 50 ,, 9 ,, ,, ,,
,, ,, $\pm$ 40 ,, 10 ,, ,, ,,

If the liquid is too dark for even the 100 mm. tube then the sucrose estimation is conducted as described sub "exhausted molasses."

10. Exhausted Molasses.

Once a day take a sample of the exhausted molasses leaving the factory, and combine the samples of 10 successive days into one sample. This is well mixed and analysed in the following way :—

Determination of Brix and Sucrose.—For the determination of the purity of first molasses we may content ourselves with the rather rough method of testing the much diluted solution, because for practical working we know for every factory what quotient of the first molasses is apt to give the best results and utmost accuracy is not therefore wanted. This is, however, the case with the analysis of the exhausted molasses, as it is very important to know exactly how much molasses, and of what constitution, has left the factory.

Weigh 500 grammes of the well-mixed sample, add 500 grammes of water and dissolve without heating. Determine the degrees Brix of this solution, multiply by 2 and then correct for the temperature. In this case the correction for the temperature should take place after the multiplication and not before, because the coefficient of expansion of the non-sugar prevailing in the cane sugar molasses differs from that of sucrose, for which material the tables of correction are calculated. This difference happens however to become neutralised when under the circumstances indicated the correction is applied after the multiplication by 2.

Weigh 26·048 grammes of the same solution, pour them into a 100 c.cm. flask, add 10 c.cm. of subacetate of lead, fill up to the mark, shake, filter and polarise; if possible in the 200 mm. tube; if not, in the 100 mm. one. The readings either multiplied by 2 or by 4, as the case may be, give the sucrose content of the molasses.

II. Sugar.

Sampling.—Take from every basketful of sugar an equal portion, and mix them in a stoppered bottle.

Determination of the Sucrose.—Once a day the sample is well mixed and 26·048 grammes are weighed, conveyed into a 100 mm. flask, dissolved with water, clarified with a minimum of subacetate of lead, filled up to the mark, shaken, filtered and polarised in the 200 mm. tube. The readings directly represent percentage of sucrose.

Determination of glucose.—25 c.cm. of the same solution that has served for the polarisation are pipetted into a 100 c.cm. flask, precipitated with a solution of 5% of carbonate and 5% of sulphate of soda, filled up with water to the mark, shaken, and filtered into a burette. With this solution 10 c.cm. of half normal test solution of copper (Fehling's test solution) are titrated as has been described sub "mixed juice."

Determination of moisture and ash.—Tare a pair of watch glasses with the clips, and weigh 5 grammes of sugar, turn over the sugar carefully in a porcelain or platinum crucible, press it gently with the finger and add 1 c.cm. of pure sulphuric acid. Put the crucible in a hot place, the sugar becomes black, swells, and fills the crucible to the brim. Heat it in a muffle oven or over a Bunsen or spirit flame in a gas cupboard till the ash is completely white or slightly pink and all particles of carbonaceous matter are burnt.

The ash is allowed to cool in a dessicator and weighed. Cleanse the crucible with a fine brush without rubbing it too hard and weigh it again, the difference is the weight of sulphate ash in 5 grammes of sugar and is calculated on 100 parts of sugar by multiplying it by 20 and subtracting 10% as a correction for the sulphates.

The same pair of watch glasses that has served for weighing the sugar for the estimation of ash is used for the determination of the moisture.

Weigh again 5 grammes of sugar, put both glasses with the sugar open in a hot air bath in which the temperature does not rise above 103° C nor fall below 100° C, and leave it there for three hours. After that time cover the sugar with the empty glass, close both with the clip, cool in the dessicator and weigh. The difference between this weight and the original one represents the moisture in 5 grammes of sugar and is calculated on 100 parts of sugar by multiplication by 20.

Undetermined.—The balance of the sum of polarisation, glucose, ash and moisture is put down as "undetermined."

Calculation of the net sugar content.—Subtract 5 times the ash and once the glucose from the polarisation.

Recapitulation of the Necessary Analyses.

Cane.—Fibre once a day.

Bagasse.—Sucrose 24 times a day. Dry substance 12 times a day.

First Mill Juice.—Brix 24 times a day. Sucrose and quotient twice a day.

Last Mill Juice.—Brix 24 times a day. Sucrose and quotient twice a day.

Mixed Juice.—Brix 24 times a day. Sucrose and quotient twice a day. Glucose once a day.

Clarified Juice.—Brix 24 times a day. Sucrose and quotient twice a day.

Syrup.—Brix, sucrose and purity twice a day. Glucose once a day.

Filterpress Cakes.—Sucrose twice a day.

First Masse Cuite.—Brix, sucrose, quotient once a day.

First Molasses.—Quotient.

Exhausted Molasses.—Brix, sucrose, quotient once every 10 days.

Sugar.—Sucrose, net analyses once a day.

(*To be continued.*)

SUGAR INDUSTRY EXPERIMENTS IN JAMAICA.

The *Agricultural News* culls the following from the Jamaica *Gleaner* of June 13th:—

We are in a position to place before our readers to-day details of the scheme for utilising the £10,000 grant-in-aid of our sugar industry, which was made by the Imperial Parliament some three years ago. This scheme is to be explained to the sugar planters of St. James and Trelawny on the 20th inst. by the Acting Governor.

Eight acres of land, forming part of the property on which Hope Gardens is situated, are to be planted out in seedling canes grown in Jamaica and imported from Barbados and Demerara. At least 2000 of these will be

planted, and from this nursery seedling canes will be distributed to the several sugar estates. The Government sugar expert will be in charge of the nursery, under the direction of Mr. H. H. Cousins.

The present laboratory building is to be doubled. The upper floor will then be converted into an efficient and well-equipped sugar laboratory which will have a staff of at least three workers. This sugar laboratory will be fitted out with special instruments and labour-saving devices to ensure accuracy and speed in the experiments and analyses to be made. Free analysis of one sample of sugar and one sample of cane juice for any sugar estate will be made during crop times.

In addition to this, a study of sugar and sugar products will be made in the several boiling houses of the island by members of the staff of the laboratory.

The lower floor of the enlarged building will be immediately in charge of the Fermentation Chemist.

Experiments in distillery will be made, a study of yeast and bacteria undertaken, and in general a detailed study of the chemistry of Jamaica rum.

It is hoped that certain properties will be discovered in our rum, by these means, whereby fraudulent sale of other liquors under the name of "Jamaica rum" will be prevented and the prosecution of the sellers rendered easy.

Rum manufacture will also be studied in all its branches on a small scale. The apparatus will consist of a small boiler and engine, a refrigerating plant, a large number of fermenting vessels of 100 gallons capacity, and a small experimental still of 50 gallons capacity, completely adaptable in dimensions, in height of head, retorts, and condensing. There will also be a rum store for the storage of rum samples. These samples will be obtained from the several estates in the island, and will be experimented on for the purposes of discovering means whereby their quality may be improved. In addition, samples of estate skimmings, molasses, and dunder skimming will be obtained from each estate, and separately experimented on, rum being manufactured from them.

Experiments in improved manufacture will also be carried out on some sugar estates.

The cost of enlarging the laboratory is estimated at £1000. The machinery will cost £1000.

Another £1000 will be devoted to the installation or modification of distillery plants on sugar estates.

The cost of running the department will amount to about £1400 a year.

£100 a year is to be devoted to providing ten scholarships, at £10 each, for the purpose of enabling distillers and estate book-keepers to come to the Laboratory for a three weeks' course in the scientific handling of apparatus, &c.

It is estimated that the £10,000 grant will run this department for a period of six years.

A small committee will advise Mr. H. H. Cousins, who will be the officer-in-charge of the department.

Briefly, this is the scheme which is soon to be explained more fully.

Refined sugar from Hong-Kong retains its position in the Corean import trade, in spite of the efforts made by the Japanese refineries to advocate their own productions.

THE ECONOMIC LIMITS OF MACERATION.

By Noël Deerr.

This subject was recently treated by Ernest E. Hartmann, (*Int. Sugar Journal*, No. 55). The writer has developed the same subject below on rather different lines.

The factors which enter into the economics of a macerating process are:—

1. The type of crushing plant, whether two or three mills.
2. The degree of admixture of the added water; connected intimately with the preceding factor as the admixture depends largely on the degree of fineness to which the megass is crushed before addition of water; the admixture also depends on the process adopted, whether the water is sprayed on as a shower or whether a lixiviation process in baths is adopted.
3. The proportion of sugar extracted for market on the total extra sugar obtained by maceration.
4. The thermal efficiency of the factory as a whole, including the boiler plant, the method of evaporation, triple or quadruple, and the general internal economy of heat.
5. The money value of the marketed sugar.
6. The cost of coal or other fuel.
7. The fuel value of the extra sugar extracted, dependant on the preceding factor.
8. The expenses of making, handling, packing, transporting, &c., the extra sugar obtained.
9. The sugar content of the cane.
10. The prime cost of the increased evaporating and other plant required to deal with the larger quantities of juice.

An attempt is made below to unite in one expression as many of these factors as possible, and to deduce the point at which the maximum profits occur.

The first step is to obtain the amount of sugar brought into the juice due to the added water; in the case of a three mill plant, let the water be added after the second mill, and let the megass be crushed to the same fibre content as after passing the second mill; then the weight of juice expressed is the same as the water added; if w be the amount of water added, and m the amount of juice remaining in the megass, both quantities referred to the same amount of cane, the amount of juice obtained per cent. on that originally remaining in the megass is $\frac{w}{w+m} \times 100$; for example, if per 100 cane there are 26·67 megass containing 12·00 fibre and 14·67 juice, to which are added 5·00 of water, and if the megass be again crushed to the same fibre content (in this case 45%), the amount of juice obtained per cent.

on that originally in the megass is $\frac{5}{14\cdot67 + 5} \times 100 = 25\cdot4\%$; the amount of sugar obtained in the megass being known, this quantity can be at once turned into sugar. In the calculations that follow a finally crushed megass of 45% of fibre has been adopted as a standard for good modern practice.

The amount of sugar brought into the juice for subsequent treatment depends on the sugar content of the cane; two types of canes have been selected for the calculations that follow; one a cane of satisfactory sugar content, containing 13·69% sugar and 12·00% fibre; on crushing this cane to a fibre content of 30%, it will give 60% of its weight as juice, the sugar content of this juice being taken as 16·15%; on a further crushing to a fibre content of 45%, a quantity of juice 13·33% on the weight of cane is obtained; this juice is considered as containing on 95% of the sugar content of the juice yielded by the first mill, and hence contains 15·34% sugar, the whole amount of juice given by the dry crushing containing 16·00% sugar; the residual juice in the dry crushed megass is 14·67% of the weight of the cane; this juice is assumed to be of sugar content 85% of that already expressed, and hence to contain 13·40% sugar; per 100 tons of cane, the megass under the above conditions contains 1·965 tons of sugar.*

The type of cane taken as one of unsatisfactory sugar content contains 10·26% sugar, and, as before, 12·00% fibre; the 60% of first mill juice contains 12·07% sugar, the 13·33% of second mill juice contains 11·46% of sugar, the residual juice in megass containing 10·20% sugar, the 26·67 tons of megass resulting from the dry crushing containing 1·495 tons of sugar per 100 tons of cane, the sugar values of the different juices being obtained as in the previous example.

If to this quantity of megass different quantities of water be added the values of $\frac{w}{w + m}$ can be calculated, and the sugar brought into the juice as the result of maceration obtained; in general, the whole of the calculated amount of sugar will not be obtained, since the added water will not mix completely with the residual juice; a factor ·85, as representing the proportion of sugar obtained to that calculated, has been adopted; this figure the writer has frequently found exceeded where a rational system of lixiviation in baths is followed; where water is merely sprayed on megass a lower figure will often result. Of the sugar thus brought into the juice, 85% is assumed to be capable of extraction for the market.

The value of this sugar in port of clearance for export is taken as £9 per ton, equivalent to 1·90 cents per pound.

On the lines indicated above, the value of the marketable sugar has been calculated for varying amounts of added water. The results are

* This method of giving different sugar values to the different juices is arbitrary, but essential to properly estimate the value of maceration processes; the values adopted are the result of many hundred analyses.

expressed in the tables below, and also, graphically, in the curves marked "*gross*." The gross value of the marketable sugar being determined, the additional cost of production must be found, so as to obtain the profits and the point at which the profits reach a maximum. The additional expenses incurred fall into three divisions:—

1. Fuel necessary to treat the additional juice.
2. Fuel necessary to replace that removed by the maceration process.
3. Extra labour, packages, transport to port, &c., of the extra sugar obtained.

The first two sources of expense in part disappear if the factory, when dry crushing, produces more than sufficient megass for its needs; it is assumed here that the factory produces either less or exactly sufficient for its working when dry crushing.

Most writers in calculating the expenses of a maceration process assume that all the added water is evaporated at triple or quadruple effect; this is not so, as owing to more sugar being brought into the juice more work is placed on the pans at single effect. The cost of evaporation as here calculated is best shown by an example. In the case of the sweeter cane, when five tons of water were added per 100 tons of cane, five tons of diluted juice containing ·424 ton sugar were obtained. Allowing that this is of purity 80, the percentage of total solids is 10·6; to evaporate this to 50% solids entails the evaporation of 3·94 tons of water, and to concentrate the resulting 1·06 tons of syrup to masse-cuite at 95% of solids requires the evaporation of ·50 ton water.

As regards the expenses of evaporation one pound of coal is taken as giving for use in the factory, eight pounds of steam evaporating in the triple* twenty four pounds, and in the pans eight pounds of water; in addition the juice has to be heated from about 80° F to near the boiling point; per ton of juice, this is taken as requiring ·016 ton of coal. The money value of coal has been taken at £2 per ton at the furnace mouth.

On reference to the tables below it will be seen that the cost of heating and evaporating the additional juice is practically the same in all cases where the added water is the same and is directly proportioned to the amount of water added, although the relative distribution between pans and triple is very different; with the data adopted above, one ton of coal will account for 20 tons of added water, that is to say if w tons of water are added the expenses of evaporation are £·w.

The amount of sugar washed out by the maceration process has already been obtained. Sugar as fuel is regarded as being worth one-half its weight of coal, and is hence worth £1 per ton; to the values so obtained 10% has been added to allow for other organic

*Evaporation at triple in preference to evaporation at quadruple effect is considered here, since probably the majority of existing factories employ the former.

combustible removed; the value of each ton of sugar marketed was taken as £9; and as an extraction of 85% was adopted for every ton of sugar marketed, 1·18 tons of sugar fuel have to be replaced, which, with the 10% addition to represent other organic combustible, account for ·144 of the value of the sugar marketed.

The expense connected with the handling, manufacture, and transport of the extra sugar is the item which will vary most with local conditions, and to which it is impossible to give any general value. In the first instance the packages alone may be estimated as costing 5s. per ton of sugar. The local transport will vary within wide limits; some few, very favourably situated, factories can ship direct into the ocean steamer; others, at small cost, are able to transport their produce by water to the port of shipment; others, which have to utilise railway transit, may have to pay as much as 5s. or more per ton of sugar. In addition there are such charges as extra curing, filling, loading, and sewing bags, &c., to be debited against the profits of maceration. As a basis of calculation, for the purposes of this article only, an extra expenditure of 10s. per ton to cover all these charges has been adopted, equivalent to ·055 of the value of the extra sugar marketed. The total of these last two sources of expenditure is almost exactly ·2 of the value of the sugar marketed. Hence, with the data adopted, the net profits of maceration are (£9S$\times$·8)—£·w or £7·2S—£·w per 100 tons of cane, S being the tons of sugar marketed, and w the tons of added water.

When the method of calculation detailed above is applied to the inefficient form of maceration represented by two mills, adding water to cane which has been crushed to a fibre content of 30%, results financially very inferior to those obtained above are indicated; the method of calculation adopted in this case is more complicated and is best explained by an example. The canes taken above as a type of sweet cane contained 13·69% sugar, of which per 100 tons of cane 9·690 tons were extracted in the first mill giving when crushed a fibre content of 30%; on crushing to 45% of fibre 13·33 tons of juice were obtained containing 2·046 tons sugar; if to the megass coming from the first mill, 5 tons of water had been added there would have been obtained 18·33 tons of diluted juice which, allowing as before a coefficient of admixture of ·85 would have contained only 1·889 tons of sugar, such a result is opposed to all experience and is due to the decreasing sugar content of the residual juice in megass. The method of calculation adopted to express the duty of added water in this case is as follows. The sugar extracted with complete admixture of added water is found and 85% of the excess over and above that obtained by dry crushing is taken as representing the amount of sugar brought into the juice as due to the maceration process. In the tables below are given the results on the calculations made on the lines indicated above; the results are also expressed graphically in the curves; the curve marked

"*gross*" has already been referred to, the curve marked "*expenses*" gives the expenditure for different quantities of added water, and the curve marked "*economic*" the resulting net profits; where this curve reaches a maximum is the critical point beyond which the profits begin to decrease.

There are three points which have not been included in the above calculations. Firstly, no allowance has been made for decreased purity of juice due to maceration. In the writer's experience this decrease, though noticeable, is not serious. This view is borne out by the figures relating to Geerligs' "System of Megass Diffusion," published in *The International Sugar Journal*, No. 60, where a much more complete extraction than found economical here is obtained. Secondly, no allowance has been made for power required to drive the third mill; with a modern engine and where the exhaust steam is utilised in evaporation the consumption of heat is very small. Thirdly, there is the question of interest on capital expenditure for increased plant where heavy maceration is adopted. It will be seen that the "*economic*" curves while at first rising very sharply, when approaching the maximum rise very slowly. This would indicate the possible advantage of designing a new factory for a maceration 5% to 10% less than the maximum indicated on the above lines.

On examining the annexed tables and curves it is at once apparent that the main factor in determining the economy of a maceration process is the relative value of sugar and coal. Any variation from the ratio adopted here entirely alters the conditions. In the case where a third mill is used the profits in all cases will probably exceed the expenditure, but where only two mills are employed a lower ratio for sugar and coal than than adopted here might easily turn a profit into a financial loss. The second factor of importance is the co-efficient of admixture. The better the admixture the greater is the quantity of sugar extracted, but the expenses of evaporation, the predominant factor in the extra expenditure, remain the same whatever the admixture.

CANES 13·69% SUGAR. THREE MILLS.

Cost or value of in £ sterling.	Tons added water per 100 tons of cane.						
	5	10	15	20	25	30	35
Heating and evaporation....	·53	1·05	1·57	2·06	2·57	3·08	3·56
Handling, packages, transport, &c.	·18	·29	·36	·41	·44	·47	·50
Sugar, &c., as fuel	·47	·74	·93	1·06	1·16	1·23	1·29
Total expenses	1·18	2·08	2·86	3·53	4·17	4·78	5·35
Marketed sugar..	3·24	5·18	6·45	7·37	8·05	8·56	9·01
Profit	2·06	3·10	3·59	3·84	3·88	3·78	3·66

Canes 13·69% Sugar. Two Mills.

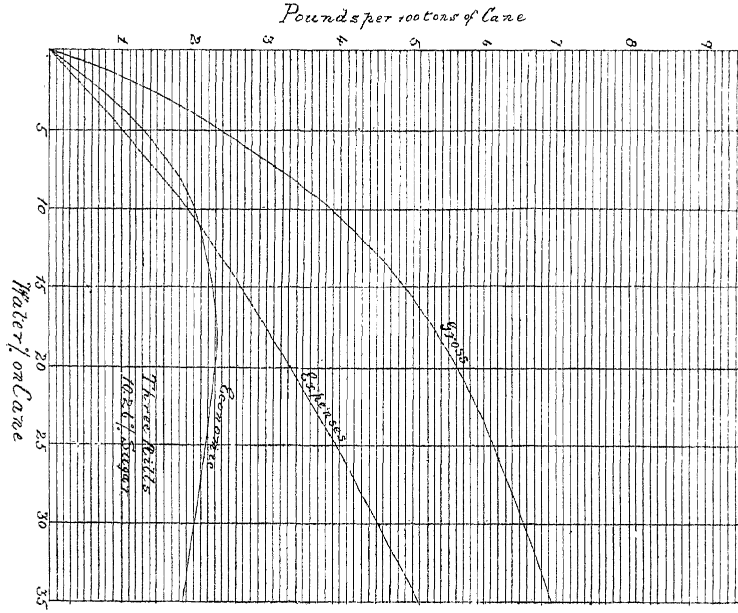
Cost or value of in £ sterling.	Tons added water per 100 tons of cane.						
	5	10	15	20	25	30	35
Heating and evaporation....	·51	1·04	1·55	2·06	2·55	3·07	3·54
Handling, packages, transport, &c.	·06	·14	·20	·25	·29	·32	·35
Sugar, &c., as fuel	·20	·47	·69	·84	·98	1·04	1·16
Total expenses	·77	1·65	2·44	3·15	3·82	4·43	5·05
Marketed sugar..	1·14	2·66	3·86	4·80	5·49	6·11	6·57
Profit	·37	1·01	1·42	1·65	1·67	1·63	1·52

Canes 10·26% Sugar. Three Mills.

Cost or value of in £ sterling.	Tons added water per 100 tons of cane.						
	5	10	15	20	25	30	35
Heating and evaporation....	·53	1·03	1·56	2·06	2·56	3·07	3·56
Handling, packages, transport, &c.	·13	·22	·27	·31	·34	·36	·38
Sugar, &c., as fuel	·35	·66	·83	·95	1·04	1·10	1·16
Total expenses	1·01	1·91	2·66	3·32	3·94	4·53	5·10
Marketed sugar..	2·36	3·93	4·89	5·61	6·03	6·54	6·93
Profit	1·25	2·02	2·23	2·29	2·09	2·01	1·83

Canes 10·26% Sugar. Two Mills.

Cost or value of in £ sterling.	Tons added water per 100 tons of cane.						
	5	10	15	20	25	30	35
Heating and evaporation....	·49	·99	1·46	2·03	2·55	3·04	3·53
Handling, packages, transport, &c.	·05	·11	·16	·19	·22	·24	·27
Sugar, &c., as fuel	·17	·42	·54	·67	·76	·85	·92
Total expenses	·71	1·52	2·16	2·89	3·53	4·13	4·72
Marketed sugar..	·97	2·07	3·06	3·69	4·25	4·70	5·13
Profit	·26	·55	·90	·80	·72	·57	·41


Pounds per 100 tons of Cane
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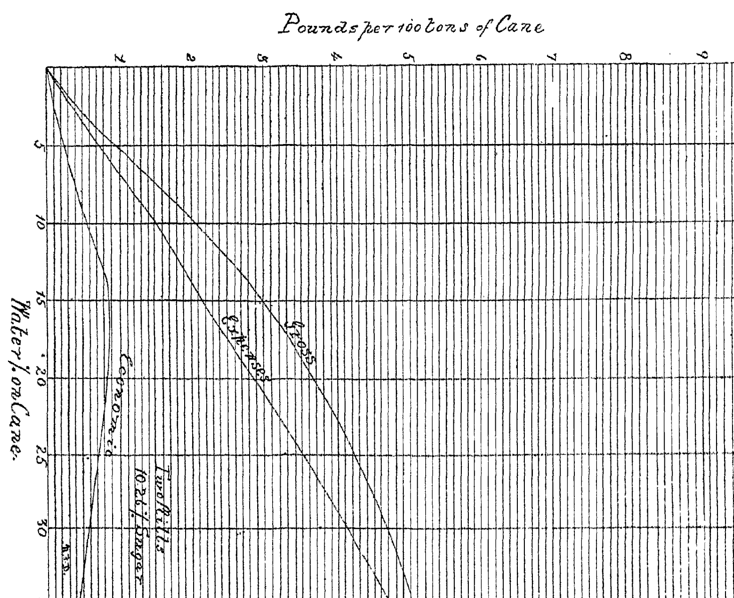
Water % on Cane
Three Mills
10.24 % Sugar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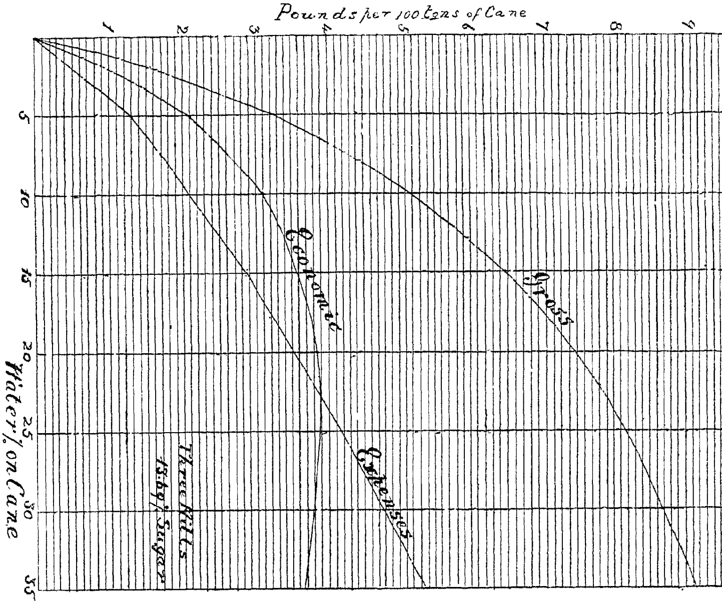
Water % on Cane.
Two Mills
10.26 % Sugar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Water % on Cane
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Gross
Expenses
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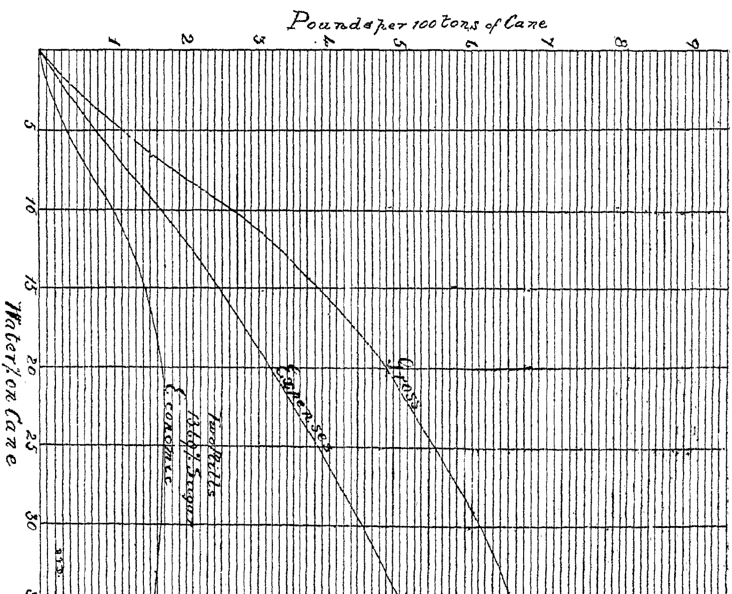
Three Mills
13.69 % Sugar


Pounds per 100 tons of Cane
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Expenses
Economic
Two Mills
13.69 % Sugar

GREEN MANURING WITH LEGUMINOSAE AS APPLIED TO THE SUGAR CANE.

BY NOEL DEERR.

In Mauritius, and in other places devoted to sugar-cane culture, green manuring with leguminous crops forms an integral part of the agricultural system. Two main schemes of obtaining the benefit of this method may be quoted.

1. The leguminous crop is grown between the cane rows simultaneously with the crop of cane; after a period of a few months' growth the leguminons crop is cut down and buried in the cane row. This method, while giving to the cane a certain amount of nitrogen taken from the atmosphere, loses the benefits of a rotation obtained by the other methods.

2. After the land has borne several successive crops of cane it is planted with leguminosae, which are allowed to remain on the ground for periods varying from one to four years, the main factor governing the period during which the soil is allowed to rest being the amount of land available.

The conservation of the accumulated nitrogen may be effected in three ways.

(*a.*) Cattle are turned into the fields to eat off the green leguminous crop, the nitrogen and other substances of manurial value being returned to the soil in their excrements.

(*b.*) The green crop is cut down, allowed to dry, and used as litter in the cattle pens, eventually finding its way to the soil as a pen manure of high quality.

(*c.*) The green crop is ploughed in directly, or after having been cut down and having become dry, is buried by manual labour.

All the above schemes aim at placing in the soil the nitrogen fixed in the leguminous crop through the agency of micro-organisms, but in Mauritius it is quite a common practice to burn off the crop of leguminosae and to apparently lose the very benefits for which the nitrogen-accumulating crop was grown, although at the same time a certain sum of money may be saved, as the crop is not buried; at the same time a certain small amount of nitrogen is placed in the soil along with the root residues, and the benefits of a rotation are obtained. To see exactly the rationale of this process, the writer grew on small plots, $\frac{1}{500}$ of an acre, two of the commonly-adopted green manures of Mauritius—the *Phaseolus lunatus* and the *Mucuna atropurpurea;* after the crops had come to maturity they were cut down, and determinations made of the nitrogen, potash, and phosphoric acid in the beans, green crop, and roots. The results of the experiment referred to dry matter, and calculated out to an acre,

are given in tabular form below. It will be seen that while combustion of the above ground crop dissipates practically all the nitrogen accumulated by the leguminous crop, it at the same time places on the soil in a readily available form large quantities of potash and phosphoric acid.

	Phaseolus lunatus. Kilos per acre.	Mucuna atropurpurea. Kilos per acre.
Weight dry matter in green crop	1621	2522
,, ,, ,, beans	132	466
,, ,, ,, roots	123	80
Nitrogen in green crop..	30·3	54·0
,, ,, beans	5·6	16·7
,, ,, roots	1·2	0·7
Potash in green crop	42·0	46·5
,, ,, beans	1·2	9·5
,, ,, roots	4·4	2·1
Phosphoric acid in green crop	11·4	14·4
,, ,, beans	·7	4·2
,, ,, roots	1·1	·4

The roots of these leguminosae extend to great depths in the subsoil, so that this process may be looked upon not as a nitrogen-accumulative but as a cheap and efficient means of subsoiling; it is too exactly analagous to the practice of burning off as opposed to burying cane trash.

The two green manures mentioned above are both pea vines, and are used in Mauritius when a one or two years' rest is given to the land, the *Mucuna* dying down after one and the *Phaseolus* after two years; where a three or four years' rest can be allowed, the pigeon pea, *Cajanus indicus*, or a Tephrosia, *Tephrosia candida*, known as Indigo sauvage are used. Both of these are woody shrubs, which enrich the soil with nitrogen through the agency of the leaves they shed annually. After three or four years the land is cleared in the usual way, the woody above-ground crop finding a use as fuel.

From the *Journal des Fabricants de Sucre* comes the news that sugar cane fibre is being used for the manufacture of straw hats. Two very smart ladies' hats so made were recently brought home from Réunion. So far only hand work has been attempted, but should mechanical defibricators be introduced, the cost of such a hat would not be great.

From the 1st August all sugar from the Dominican Republic (not including molasses and sugar sweetened goods) will be debarred entry into the United Kingdom on account of the bounties granted in that country.

MANUFACTURE OF ALCOHOL FROM SUGAR BEET ROOTS.

By Sigmund Stein.

(Sugar Expert, Liverpool.)

In previous numbers of this Journal I have given several papers dealing with the manufacture of alcohol from sugar beet roots. This question has aroused, as I mentioned before, a very great interest in this country, and I have been asked to give more information, especially as regards the cost of a plant for the manufacture of such alcohol; and also more details about the profitableness of such an industry.

As we know, alcohol is now used more and more extensively on the Continent for lighting, heating, and motor purposes. This movement has also commenced, though slowly, in England. The British Chancellor of the Exchequer and the President of the Board of Agriculture have both been approached with a view to obtaining facilities for the manufacture of duty free alcohol. I am told that several Committees have been formed in this country for the purpose of agitating for the freeing of alcohol from all taxation, and for pushing the use of alcohol for lighting, heating, and motor purposes. The Automobile Club of Great Britain and Ireland, and the Automobile Club in Leeds, the London Chamber of Commerce, the Society of Chemical Industry, &c., are all doing their best to create an interest, and to establish the advantages of duty-free alcohol.

The sugar beetroot is an excellent plant for the manufacture of this cheap alcohol in many ways. The great saccharine content to which the British farmers have brought beetroots during my many years' experience, is a guarantee of the future prosperity of a British Sugar Beet Distillery, as the richer the roots are in sugar content the more alcohol will be produced, and the more profitable the business will be. The quantity of beet roots required for a distillery is not very large, and a few farmers could combine and guarantee to the distillery the whole supply of beetroots for the manufacture of Alcohol. Many hundreds of farmers would be willing to supply the beetroots to a distillery at a price of £1 per ton, delivered at the factory.

The capital required for such an establishment is not large, and the works could easily be situated in the midst of one of our large estates. I have been asked several times by different people in the country for estimates for the machinery and building for a distillery working sugar beetroots. I propose to give here an outline of such a distillery to work 60 tons of beetroots in 24 hours, and produce therefrom 1,000 gallons of pure alcohol (96% strength).

The installation of such a distillery would include the following machinery :—

An elevator.

Beetroot washing machine.

One slicing machine.

One diffusion battery (complete with all accessories).

One refrigerator.

Various vats for fermentation.

One still (which is able to work 20,000 gallons of fermented juice in 24 hours, complete with all accessories).

Different juice pumps; for the fermented juice; for distiller's wash; for water, &c.

One steam engine.

Various tanks for alcohol, &c.

The cost of such an installation would come to about £5,000.

In any case I should be glad to give interested parties the exact estimate and specification regarding such a distillery.

BALANCE SHEET OF AN ALCOHOL DISTILLERY WORKING 1,000 GALLONS OF (96%) ALCOHOL PER DAY, for a campaign of 120 days.

Dr. | *Cr.*

	£	s.	d.		£	s.	d.
5,400 tons of sugar beets @ £1 per ton (45 tons per day, 120 days working).	5400	0	0	120,000 gallons of spirit @ 1s. 3d. per gallon	7500	0	0
Working expenses including depreciation	2050	0	0	2,800 tons of pulp @ 10s. per ton	1400	0	0
Profit..	1450	0	0				
	£8,900	0	0		£8,900	0	0

Taking the capital of this distillery at £8,000, the profit would thereupon be more than 18% on the invested capital.

In the price of the sugar beetroots given above, there is a very handsome profit to the farmers themselves. If the latter would be at the same time distillers, they would obtain a treble profit, viz. :—

1. From the cultivation of the sugar beetroots.
2. By re-selling the pulp at reasonable prices.
3. From the profit of the production of alcohol.

As I emphasized in several pamphlets I have published before, the feeding value of the pulp (exhausted slices) is very great, and the farmers would also derive a great indirect benefit in cattle feeding.

Austria-Hungary.

Sugar exported from Trieste in 1903 :—

Exported to.	Quantities. Metric tons.
Austro-Hungarian ports	3,829·3
Italy	1,300·5
Malta	4,176·7
Turkey	71,741·5
Bulgaria	2,997·0
Tripoli	2,940·8
India	6,203·8
Japan	7,229·1
Total exportation in 1903	126,250·3
,, ,, in 1902	200,075·8
,, ,, in 1901	175,604·3

In Turkey and Egypt there was strong Russian competition. The sugar export to Africa was stationary; to Persia, diminishing. In Japan, Russian and German competition was very strong.

France.

In dealing with the French Budget for the year 1904 the Report states :—The following figures show the revenue from sugar:

	Amount. £
1902	6,935,000
1903 (estimate)	5,372,000
1904 ,,	5,487,000

The estimate for 1903 will probably prove, however, to have been exceeded by over £500,000. Otherwise it would not have been possible to anticipate the figure given above for 1904, the whole of which year will see in operation the reduced internal duty designed to counteract the effect of the abolition of export bounties, whereas only the last four months of 1903 were affected by it. The new duty is 25 fr. per 100 kilos., as compared with 62 fr. before September 1st last. It was estimated that sugar would be cheapened some 40 per cent. by the reduction, and that the home consumption would rise about 20 per cent. In round figures the produce of France and her colonies in sugar is about 1,100,000 French tons a year. The annual home consumption of late years has been between 420,000 and 440,000 tons, the remaining quantity being exported, namely, from 660,000 to 680,000 tons. A fall in sugar exports was, of course, inevitable. The forecast as to increased home consumption is being fairly realised, but the result of the abolition of bounties has been a falling-off in the sugar revenue of about £1,500,000 a year.

Dunkirk.—The results of the Brussels Sugar Convention, as far as the export of sugar from Dunkirk is concerned, have been most

marked, the figures in 1903 being only 33,564 tons compared with an average of 151,892 tons during the five years ending 1902. The French consumer has, however, to thank the Convention for a reduction of close upon 2d. per lb. in the retail price of sugar. The consumption is stated to have increased considerably in those countries which have adhered to the Convention. From September 1st, 1903, to the end of March, 1904, compared with the similar period ending March, 1903, it has been estimated that in Germany, Austria-Hungary, France, Belgium, Holland and North America there has been a total increase of about 16 per cent. in the consumption. In France the figures given are 446,052 tons against 270,298 tons in the corresponding period of the previous year.

During the season 1903-04, up to March 31st, the production of sugar in France amounted to 768,442 tons, a reduction of 47,903 tons compared with the preceding season. On the other hand there has been a very large increase in the production of alcohol from beet. At the end of February (first five months of the season 1903-04) it amounted to 23,550,000 gallons against 10,830,000 gallons in the preceding corresponding period.

It is reported that the acreage under beet this year will show a falling-off of from 15 to 20 per cent.

PORTUGAL.

Chinde.—There are two companies growing sugar on the Zambezi, one at Mopea, called the Companhia do Assucar de Moçambique, and the other the Sociedade Assucareira da Africa Oriental Portugueza. The latter started on January 1, 1899, with a Franco-Portuguese capital of £180,000. The factory is about 600 miles from Chinde, and leases 2,500 acres from the Luabo Company. There are about 10 to 12 Europeans of different nationalities, principally French, and from 1,300 to 1,400 natives employed on the estate, which has about 1,200 acres under cultivation. Irrigation and cultivation are carried on by the latest improvements the outdoor appliances being supplied by a British firm; the machinery for sugar manufacture is from France.

The Portuguese Government allow 6,000 tons of sugar from the east coast, at a preferential tariff, to enter Lisbon; anything beyond this amount pays full duties. As will be seen by the following table the limit has not yet been reached:—

	Quantity. 1899.	1900.	1901.	1902	1903.
	Tons.	Tons.	Tons.	Tons.	Tons.
Mopea	1,630	2,560	1,250	1,792	2,050
Marromeu	—	1,310	300	2,970	1,200
Total	1,630	3,870	1,550	4,762	3,250

No rum was manufactured in 1903, there being no market since the Boer war. The export duty is 1 per cent. *ad valorem* on sugar leaving this port.

RUSSIA.

Odessa District.—The manufacture of sugar, which had greatly advanced, received a severe blow at the end of 1903 by a fire which almost entirely destroyed the Odessa Company's works.

The internal market for Odessa is practically confined to the South of Russia. The external market now includes Persia, where Russian sugar can to some extent compete with French sugar, but it must be supplied in so-called "Marseilles loaves," which are still the fashion in that country.

The exportation of sugar to Persia from Odessa has been helped by the regular service to the Persian Gulf of the steamers of the Russian Steam Navigation and Trading Company and by the opening of the new road from Enzeli to Teheran, but the beetroot sugar factory in Teheran is a formidable rival.

The area under beetroot cultivation is this district is considerably less this year than in 1903, and this statement applies individually to each of the Governments included in it. According to statistics published in the "Viestnik Finansov" No. 21 of May 23/June 5, 1904, the total area under cultivation last year was 1,136,619 acres, while this year it has fallen to 965,021 acres. In the four principal sugar-growing governments—Kharkof, Kieff, Kursk, and Podolia—the reduction amounts to 16, 12, 19, and 17 per cent. respectively.

CHINA.

Newchwang.—Imports of sugar:—

	Average, Five years 1897-1902 (excluding 1900). Cwts.	1902. Cwts.	1903. Cwts.
Foreign sugar	137,410	265,834	155,719
Native sugar.. ..	129,856	135,426	88,580

Wuhu.—The British Consul at Wuhu states:—The trade of Wuhu being carried on almost entirely with other Chinese ports, and not with foreign countries directly, the foreign goods imported consist chiefly of re-exports from Shanghai, and it seems therefore unnecessary to notice them in detail.

I would, however, call attention to the steady process by which the native sugar is being superseded by the "foreign" sugar from the refineries of Hong Kong and Swatow. The figures for the last five years bring this out clearly:—

Year.	Foreign Sugar. Quantity. Cwts.	Foreign Sugar. Value. £	Native Sugar. Quantity. Cwts.	Native Sugar. Value. £
1899	123,390	76,163	146,363	99,555
1900	106,435	68,978	125,236	90,665
1901	135,430	91,289	107,213	80,203
1902	188,360	110,092	95,462	58,698
1903	200,181	123,776	90,673	59,822

JAPAN.

Sugar was imported to the value of £2,140,282 as against £1,476,924 in 1902. This large increase was entirely in raw sugar, for which there has been an active market throughout the year. In this trade the Dutch Indies have had by far the largest share, as will be seen from the following table:—

Year.	Value. Dutch Indies. £	Philippines. £	Germany. £	Austria-Hungary. £	Hong-Kong. £	Total. £
1900	249,000	178,000	349,000	317,000	1,050,000	2,716,000
1901	280,000	277,000	899,000	415,000	1,110,000	3,419,000
1902	579,000	105,000	332,000	117,000	237,000	1,476,000
1903	975,000	294,000	283,000	255,000	157,000	2,140,282

The receipts from Hong-Kong were even less than in 1902. In former years the value of the Hong-Kong sugar trade with Japan often exceeded £1,000,000, and was seldom much below that figure. It has suffered from the competition of the bounty-fed article and of the Japanese refineries. These latter receive encouragement from the Japanese Government in the shape of a rebate on raw sugar, established in 1902, the duty of 27 sen per 133 lbs. being refunded on sugar below Dutch standard No. 14 if refined within a year. There are two refineries at work in Japan, one at Ozaba and the other at Tokio. According to the reports of these companies, their sales amounted in 1902 to 13,000 tons and 9,000 tons respectively. Both are increasing their plant, and a large refinery is being erected near Moji, which is expected to begin working this year. The Japanese demand for sugar is a constantly growing one, and time must elapse before the native refining industry is in a position to satisfy it. Latterly, bounty-fed beet sugar has supplied the deficiency, but the situation should undergo a change now that bounties have been abolished in Europe. It is too early to judge how far their abolition will permanently benefit the Hong-Kong trade with Japan. At present it looks as though it might help it, for since the abolition of the bounties in September last there has been a marked falling-off in the importation of German and Austro-Hungarian beet sugar.

The British Consul at Shimonoseki reports:—At the end of 1902 Osaka and Tokio refineries completed their arrangements for supplying the market in this district, and during the year under review did a fair business to the detriment of importers of refined sugar. The

quality and price compared favourably with Hong-Kong refineries, and with increased distributing facilities the demand for sugar refined in the country is bound to grow.

A local refinery established at Dairi, about five miles from Moji, by one of the largest sugar merchants of Kobe, has been completed, and at the time of writing (April, 1904) a consignment of raw sugar has arrived from Java. The raw material will be principally drawn from Java, whence direct transport has been much facilitated by the establishment of the "Java, China and Japan Line" of Dutch steamers, with regular 25 days' sailings. The estimated turn-over of this refinery is 1,000 piculs (about 1,200 cwts.) per day, increasing to 3,000 piculs. Apart from the opposition from the local refineries, the improvement in the price of silver has had an adverse effect on the importation of Hong-Kong refined sugar.

JAVA.

The British Consul reports:—The year 1903 proved to be a more prosperous one for Java than its predecessor. The sugar crop was a record one, the total reaching 883,020 tons, or nearly 35,000 tons in excess of the year 1902, and prices ruled considerably higher than during 1902. The results obtained, however, in the various divisions of the island were very dissimilar. In East Java, where the long dry monsoon referred to in my previous report was regarded as likely to prove unfavourable to the production, heavy rains fell early in the year, entirely altering the aspect of affairs, and the quantity produced was 500,507 tons, as against 463,364 tons in 1902 and 436,032 tons in 1901. The increase in production amounted to about 8 per cent., although the area planted for 1903 was about 1 per cent. less than in 1902.

In Mid Java heavy rains fell at frequent intervals during the milling season, and although the crop was the largest so far produced, being 228,604 tons as compared with 222,546 tons in 1902 and 182,833 tons in 1901, the percentage of sugar in the cane was very disappointing.

In West Java, where the weather was also unfavourable, the crop obtained from practically the same area as in the previous year amounted only to 153,907 tons, while in 1902 and 1901 the figures were 162,111 and 147,477 tons respectively.

The following table gives the production in each of the past five years:—

Year.	Quantity. Tons.
1899	730,842
1900	710,150
1901	766,342
1902	848,021
1903	883,020

The prices obtained were much more satisfactory than in the preceding year, the lowest point reached being the equivalent of 7s. 3d. per cwt., as against 6s. 2d. per cwt. in 1902.

Notwithstanding the low values of the last two years, only five mills in all Java have been compelled to close.

Prospects for the 1904 crop are at present very uncertain. Too much rain has fallen in some districts, and in others drought has prevailed. Everything now depends on the weather conditions during the next few months.

The exports of sugar—from the 1903 crop up to the end of the year—to the United States show a falling-off, as compared with 1902, of 156,049 tons, while on the other hand 61,227 tons more went to Japan, 38,289 tons more to India, and 37,589 tons more to China. Exports to the United Kingdom, which for some years have been practically nothing, according to the official figures reached 26,126 tons, but the actual quantity was probably somewhat more.

In view of the uncertainty as to the continuance of the United States as the principal consumer of Java sugar, every effort is being made to increase the volume of trade with Eastern markets.

Exports of sugar crop for year ending December 31st, 1903, compared with the years 1901 and 1902:—

Country.	Quantity. 1901.	1902.	1903.
United States	292,169	405,368	249,319
China	148,603	134,033	171,622
Japan	36,694	47,458	108,685
Australia	83,099	71,717	72,096
British India	14,936	21,324	59,613
United Kingdom	—	35	26,126
British Columbia	9,984	10,648	10,868
Continent of Europe	—	1,596	1,302
Other countries	23,561	19,218	34,950
Total	606,046	711,397	734,581

PUBLICATIONS RECEIVED.

"DIE CHEMIE DER ZUCKERARTEN." By Prof. Dr. Edmund O. von Lippmann. Friedr. Vieweg & Sohn, Braunschweig, Germany. 2 Vols. Mks. 34.

The third and enlarged addition of this work illustrates, in a striking manner, the rapid extension of knowledge in a comparatively small but most important branch of chemical inquiry; more new facts having been brought to light during the past ten years than in the preceding century. The enormous task of collecting and arranging

the new material has been undertaken and successfully accomplished by the author, and the present edition embodies the results of recent researches, to which copious references appear in the text.

Space has been economised by assuming the reader to be familiar with the principles and practice of analytical methods, references to which are of a brief and general description.

Part I., occupying the first volume, devotes over 1,000 pages to the glucoses, or monoses. Parts II., III., and IV. deal respectively with the di-, tri-, and tetra-saccharides, 388 pages in Part II. being occupied with saccharose, or cane sugar.

The second volume closes with Part V., which contains much interesting matter under the following heads:—

1. Constitution, configuration, and synthesis of the sugars.
2. The relations between the optical and other physical constants.
3. The formation of sugar in the plant.
4. The physiological importance of the sugars.

The work is finely printed and carefully indexed, and forms a most valuable addition to the library of the sugar expert and chemist.

"CALCULATIONS USED IN CANE SUGAR FACTORIES." By Irving H. Morse. New York, John Wiley & Sons; London, Chapman and Hall.

This is a small book of seventy-five pages containing brief instructions for analysis, worked out examples of the principal problems which occur in sugar house control and detailed tables for simplifying these calculations; the formulae given include those necessary to find the available sugar in a juice or masse-cuite, and others useful in the control of crystallisation in motion processes are given; the tables supplied are very complete but unfortunately for English workers the American gallon of 8·33 lbs. is adopted, the book being written in the first place for use in Louisiana and Cuba.

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. THOMPSON, C.E., F.C.S., M.I.M.E., Chartered Patent Agent, 6, Lord Street, Liverpool; and 322, High Holborn, London.

ENGLISH.—APPLICATIONS.

13833. S. STEIN and M. LOEWENTHAL, Liverpool. *Improved manufacture of sugar and other food for diabetics.* 18th June, 1904.

15297. V. DREWSEN, London. *Process of manufacturing products from cornstalks, sugar cane and analogous pithy stalks.* (Complete specification.) 8th July, 1904.

ABRIDGMENT.

15862. A. J. Boult, London. (A communication from the firm Fr. Meyer's Sohn, Tangermünde, Prussia.) *Improvements in centrifugal machines and the like.* 17th July, 1903. This invention relates to centrifugal machines and the like, and has for its object the provision of means for accurate separation of substances of different weights in the centrifugal machine.

GERMAN.—ABRIDGMENTS.

148971. Count Botho Schwerin, Weldenhoff, East Prussia. (Patent of Addition to Patent No. 124430, October 27th, 1900.) *Process for the extraction of sugar by means of electricity.* 16th April, 1901. By a modification of the process described in Patent 124430, it is possible to obtain the sugar as a colourless water-clear syrup directly in a form perfectly free from albumen, which syrup may without furthur treatment be subjected to crystallization whereby a pure white product is obtained. The improvement leading to this result consists in employing at the porous negative pole a layer of carbon which need be only slight and is located between the wire gauze and the material.

150364. Askan Müller, of Hohenau, near Vienna. *A juice arrester for evaporating and boiling down apparatus.* 16th Jan., 1903. In order to separate the particles of juice from the vapour, there is imparted to the latter a whirling movement in a centripetal direction by means of a funnel shaped vessel provided with tangential slots arranged in the juice boiler. The thereby condensed particles of juice carried along in the vessel, unless they are already deposited on the bottom of the funnel, are caught in a brush arranged in the centre of the vessel, and returned to the other juice in the pan.

IMPORTS AND EXPORTS OF SUGAR (UNITED KINGDOM)

To end of June, 1903 and 1904.

IMPORTS.

Raw Sugars.	Quantities.		Values.	
	1903. Cwts.	1904. Cwts.	1903. £	1904. £
Germany	1,802,718	3,607,137	727,108	1,592,954
Holland	130,415	80,176	49,006	32,935
Belgium	604,949	166,624	252,208	70,600
France	385,350	102,137	171,612	45,959
Austria-Hungary	1,322,727	676,136	556,205	305,200
Java	....	925,070	....	380,837
Philippine Islands	70,646	....	25,285	....
Cuba	174,473	....	86,363	....
Peru	156,574	523,654	59,393	234,828
Brazil	65,186	81,793	25,505	31,039
Argentine Republic	101,326	....	44,176	....
Mauritius	222,170	255,172	78,546	93,355
British East Indies	101,215	112,107	36,491	45,395
Br. W. Indies, Guiana, &c.	466,333	708,236	288,310	454,173
Other Countries	208,423	363,348	94,479	165,865
Total Raw Sugars	5,812,505	7,601,590	2,494,687	3,453,140
Refined Sugars.				
Germany	7,023,726	5,795,579	3,641,671	3,241,432
Holland	1,040,730	1,554,612	600,791	911,987
Belgium	74,865	222,051	43,555	126,296
France	444,366	1,105,531	254,672	599,977
Other Countries	504,299	163,120	247,962	86,295
Total Refined Sugars	9,087,986	8,840,893	4,788,651	4,965,987
Molasses	748,019	869,088	142,134	160,729
Total Imports	15,648,510	17,311,571	7,425,472	8,579,856

EXPORTS.

British Refined Sugars.	Cwts.	Cwts.	£	£
Sweden and Norway	12,904	14,311	6,728	7,231
Denmark	50,420	60,310	27,674	30,616
Holland	31,051	27,579	16,900	14,354
Belgium	4,303	5,683	2,138	3,029
Portugal, Azores, &c.	4,005	9,035	2,162	4,798
Italy	5,422	2,457	2,467	1,159
Other Countries	280,668	157,336	169,714	97,407
	388,773	276,711	227,783	158,594
Foreign & Colonial Sugars.				
Refined and Candy	20,953	15,320	12,612	10,375
Unrefined	30,320	53,820	15,825	29,377
Molasses	1,206	634	616	343
Total Exports	441,252	346,485	256,836	198,689

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1904. Tons.		1903. Tons.
Total Receipts, 1st Jan. to July 21st ..	1,108,650	..	1,054,086
Receipts of Refined ,, ,, ,, ..	314	..	1,124
Deliveries ,, ,, ,, ..	1,097,569	..	977,023
Consumption (4 Ports, Exports deducted) since 1st January	983,347	..	868,326
Importers' Stocks (4 Ports) July 20th ..	23,242	..	81,448
Total Stocks, July 27th	166,000	..	307,032
Stocks in Cuba ,, ...	107,000	..	278,252
	1903.		1902.
Total Consumption for twelve months ..	2,549,643	..	2,566,108

CUBA.

Statement of Exports and Stocks of Sugar, 1903 and 1904.

(Tons of 2,240lbs.)	1903. Tons.		1904. Tons.
Exports	569,298	..	896,073
Stocks	358,397	..	161,819
	927,695	..	1,057,892
Local Consumption (six months)	19,950	..	20,900
	947,645	..	1,078,792
Stock on 1st January (old crop)	42,530	..	94,835
Receipts at Ports up to June 30th	905,115	..	983,957

Havana, June 30th, 1904. J. Guma.—F. Mejer.

UNITED KINGDOM.

Statement of Imports, Exports, and Consumption for Six Months ending June 30th.

Sugar.	Imports. 1902. Tons.	1903. Tons.	1904. Tons.	Exports (Foreign). 1902. Tons.	1903. Tons.	1904. Tons.
Refined	542,235	454,399	442,045	1,324	1,048	766
Raw	403,485	290,625	380,079	2,035	1,516	2,691
Molasses	32,303	37,401	42,454	59	60	31
Total	978,023	782,425	865,578	3,418	2,624	3,488

	Home Consumption. 1902. Tons.		1903. Tons.		1904. Tons.
Refined	542,197	..	428,098	..	453,292
Refined (in Bond) in the United Kingdom	—	..	—	..	246,948
Raw	385,246	..	270,811	.	62,650
Molasses	31,614	..	33,115	..	41,046
Molasses, manufactured (in Bond) in U.K.	—	..	—	..	31,170
Total	959,057	..	732,024	..	835,106
Less Exports of British Refined	14,603	..	19,439	..	13,836
Total Home Consumption of Sugar	944,454	..	712,585	..	821,270

STOCKS OF SUGAR IN EUROPE AT UNEVEN DATES, JULY 1ST TO 27TH, COMPARED WITH PREVIOUS YEARS.

IN THOUSANDS OF TONS, TO THE NEAREST THOUSAND.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	TOTAL 1904.
92	693	571	269	167	1792

	1903.	1902.	1901.	1900.
Totals	1959 ..	2062 ..	1130 ..	975

TWELVE MONTHS' CONSUMPTION OF SUGAR IN EUROPE FOR THREE YEARS, ENDING MAY 31ST, IN THOUSANDS OF TONS.

(From Licht's Monthly Circular.)

Great Britain.	Germany.	France.	Austria.	Holland, Belgium, &c.	Total 1903-4.	Total 1902-3.	Total. 1901-2.
1770	979	653	451	542	4395	3774	4114

ESTIMATED CROP OF BEETROOT SUGAR ON THE CONTINENT OF EUROPE FOR THE CURRENT CAMPAIGN, COMPARED WITH THE ACTUAL CROP OF THE THREE PREVIOUS CAMPAIGNS.

(From Licht's Monthly Circular.)

	1903-1904. Tons.	1902-1903. Tons.	1901-1902. Tons.	1900-1901. Tons.
Germany	1,950,000 ..	1,762,461 ..	2,304,923 ..	1,984,187
Austria	1,165,000 ..	1,057,692 ..	1,301,549 ..	1,094,043
France	790,000 ..	833,210 ..	1,123,533 ..	1,113,893
Russia	1,200,000 ..	1,256,311 ..	1,098,983 ..	918,838
Belgium	210,000 ..	215,000 ..	334,960 ..	333,119
Holland	125,000 ..	102,411 ..	203,172 ..	178,081
Other Countries.	410,000 ..	325,082 ..	393,236 ..	367,919
	5,850,000	5,552,167	6,760,356	5,990,080

THE

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All Advertisements to be sent *direct*.

Cheques and Postal Orders to be made payable to Norman Rodger, Altrincham.

☞ The Editor is not responsible for statements or opinions contained in articles which are signed, or the source of which is named.

NOTES AND COMMENTS.

Blyth Bros., Mauritius, report shipments of sugar from August 1st to July 21st, 1903-04, as 217,942 tons, as compared with 148,922 tons for the corresponding period of 1902-03.

The Future of the French Industry.

The *Times* states that the fears for the future of the French sugar industry occasioned by the closing of foreign markets, and particularly the English, seem to have been dispelled by the measures adopted and in particular by the reduction of the Excise Duty on home consumption from £2 8s. to £1 per 220 lbs. During the nine months ending in June the French consumption increased by 50 per cent. A further marked increase is to be anticipated, as the beetroot crop has been excellent. Owing to the exemption from taxation of denaturalised raw sugar used for cattle feeding and the almost complete exemption of that employed in breweries, the return of the sugar industry to a normal condition may be regarded as certain in less than a year's time.

Canadian Preference for Imported Sugar Machinery.

In the Dominion House of Commons in July the Finance Minister announced some additional changes he proposed to make in the tariff. One item was the extension for another year of the clause allowing the free importation of sugar machinery. Molasses also is admitted

free; but it must be brought direct from the country of manufacture, to prevent mixing and adulteration.

Chinese Labour.

A good deal of political agitation has been occasioned of late owing to the introduction of Chinese labour into South Africa. Amongst the mass of correspondence appearing in the press on this subject, a letter from Penang was reproduced in the *Times*, describing the system of Chinese labour in the Straits. The writer, Mr. John Turner, a leading planter and member of the Legislative Council of that Colony, states:—

Some 12 years ago a section of Caledonia Estate, Province Wellesley, was given over to Chinese coolies for cane growing, the estates buying the canes when ripe. This proved a complete success, so much so that in the course of four years over one-third of the estate's crop of some 6,500 tons was made from canes grown by Chinese in that way.

Encouraged by the success of Chinese as agriculturists, I secured two concessions of land for sugar estates, one in the Kurau and one in the Teluk Anson district. These two estates now produce canes for a crop of between 7,000 and 8,000 tons of sugar, three-fourths of which is grown by Chinese.

For the manufacture of sugar the estates are equipped from Glasgow with machinery of the most powerful type made for that purpose, and to keep them supplied with all requirements the yearly bill from England amounts to a quarter of a million dollars.

For the general working and management of these estates there are 48 Europeans, who derive their incomes solely from the estates, and in addition there are many Europeans who benefit both directly and indirectly from them. There is also a large staff of clerks and about 4,500 labourers of other nationalities, who are employed in the lighter work of transporting canes, manufacture of sugar, &c.

It is worthy of mention that since these Chinese commenced growing canes for us there have been no differences between them and the estates' authorities of any moment—not a single complaint before the magistrate; whereas with the Tamil coolies working in the same way there have been several.

A Chinese coolie can and does cultivate $2\frac{1}{2}$ acres of land, whereas a Tamil will work only $1\frac{1}{2}$, and that not nearly so thoroughly.

Cuba's Crop.

As will be seen from a glance at Guma's monthly report at the end of the journal, the Cuban crop has at last exceeded the million tons. The last occasion when these figures were passed was in 1895; but the subsequent war set back matters so much that it has taken nine years to again equal that record. The present year's total would have been larger still but for very unfavourable weather, a cyclone, accompanied by torrential rain, having swept over the island in June.

THE FRENCH SUBSTITUTE FOR REFINING IN BOND.

In February last we dealt somewhat fully with this subject, giving a brief history of the controversy since 1872 and a clear statement of the point at issue. The Convention of 1888 put it very clearly by stating that "the high contracting parties engage to levy the tax on the quantities of sugar intended for consumption without granting on exportation any drawback or repayment of duties, or any writing off which can give rise to any bounty."

The French Goverment declines to adopt this system, in spite of the fact that every other country, party to the Convention of 1903, has done so. It insists on a provisional liquidation of the duty on the raw sugar entering the refinery in order to avoid deceptions and frauds which would otherwise occur. For the last thirty years our Government have constantly urged, in reply to this plea, that from the point of view of an international agreement for the abolition of bounties such a system is no security; nor is it any security from the point of view of the protection of the French revenue. They have urged again and again, as the sole security, that duty should be paid only on the refined sugar which goes into consumption, because then the exported sugar, having paid no duty, will receive no drawback, and therefore no bounty. They took care that this principle was clearly stated in the Convention of 1888, and every country but France has now acted upon it. As we pointed out last February, so long as duty is paid on the raw sugar and drawback given on the refined exported, we have nothing to rely upon but the assurance of the French Government that their accounts are well kept. "That is no international security; and, moreover, the very fact of their clinging to a difficult, complicated and unreliable system, when an easy, simple, and secure one would better answer the purpose, must necessarily give rise to the very natural assumption that there is some hidden reason for so tortuous a proceeding."

We are pleased to find our views entirely confirmed in an article in the *Journal des Débats*. The writer puts the matter very clearly. He points out that "every foreign legislation since the Brussels Conference levies the duty on going out of the refinery. By this means, the simplest of all, they have the advantage of taxing the sugar at the very moment when it goes into consumption. Thus every error, every dispute is abolished. The levying of the duty is simplified in the most perfect way possible." He proceeds to explain that the project of the Finance Minister is quite different, and consists in levying the duty on the sugar entering the refinery, with an allowance for loss of weight of $1\frac{1}{2}$ per cent., a verification of the products going out, and a yearly inventory. This he regards as offering no better guarantee than that of simply levying the duty on going out, while it

"presents numerous causes of error, notably in the establishment of annual inventories." "In fact," he concludes, "the levying of duty on entering the refinery, while one portion of the sugar after being refined is exported, involves the existence of drawbacks. These drawbacks can constitute a bounty. . . . . The French Government will be compelled, sooner or later, to adopt, like the other signatories of the Brussels Convention, the system of levying the duty on going out of the refinery."

This anticipation of the *Journal des Débats* has unfortunately not been realised, or if it is realised it will have to be later rather than sooner. The Permanent Commission at Brussels has come to the amazing decision that though the French system is not in strict conformity with the terms of the Convention, it is to be permitted. The *Journal des Fabricants de Sucre*, in its issue of the 17th ult., quotes from the minutes of the twenty-third sitting of the Commission, of the 10th March, 1904, to show why the Commission arrived at this decision. It appears that the French Delegate, M. Delatour, declared that there was no drawback or return of duty. This, of course, is an entirely misleading statement. The sugar receives a certificate of export, a document which is bought and sold on the market, and appears in the daily Bourse quotations. It is in fact as good as a bank note. The other quotation is from a speech of M. Beauduin, the Belgian Delegate, who said: "Perhaps this system is not in principle the absolute carrying out of refinery in bond; but, in effect, the object aimed at by the Convention is attained; it is impossible that any quantity leaving the refinery can escape the duty." The honorable Delegate entirely misses the point. Whether sugar will escape duty depends entirely on the strictness of the supervision. But if no duty were paid and no drawback given it would be immaterial, from the international point of view, whether the supervision were strict or lax. On the other hand, from the international point of view, it is impossible to rely only on a supervision the strictness of which it is impossible to verify. And yet these are the arguments which, according to the *Journal des Fabricants de Sucre*, sufficed to satisfy the Permanent Commission.

The *Journal Officiel* of the 15th ult. gives the text of the Decree determining the obligations to which the refiners will be subject in carrying out this supervision. It is clear from our previous explanations that even if this Decree established an absolutely perfect supervision, it would not in any way remove or diminish the fundamental objection to the system. It is not refining in bond, and therefore no supervision can possibly make it so. A system of supervision however perfect on paper is not necessarily perfect in practice. Any criticism of this Decree, therefore, has no bearing on the main question. Still it may be interesting to give a brief glance at some of its provisions. It is instituted in order to carry out the provisions of

Article IV. of the law of 9th July, 1904, which says that regulations shall determine the obligations of the refiners "Concerning especially the form and control of *the declarations* as to deliveries from the refinery and as to the quantities existing at the stock-taking." This shows that a considerable part of the supervision takes the form of receiving "declarations" from the refiners. These declarations are to be "controlled." All will depend on how this is done. According to this Decree the raw sugar entering the refinery will be verified by the excise officers, who "will proceed, *if it is necessary*, to weigh it and take samples for analysis." As to the sugar leaving the refinery, every delivery will be "verified" by the officer "by means of weighing, counting, *reconnaissance* of tare, *under conditions determined by the administration*." Everything depends on those conditions, which seem to be left an open question. "Each package or group of packages presented for verification is accompanied up to the moment of leaving the factory by a bulletin bearing a number and *issued by the refiner*. This bulletin, indicating according to the kind of package the net weight of sugar contained in it, is examined (visé) by the officer at the moment of verification." "The refiner establishes a delivery sheet reproducing the indications of the above-mentioned bulletin, and mentioning, according to the nature of the package, the net weight of each load. This sheet, examined (visée) by the officers, accompanies the load up to the door of exit, where it is handed to the supervising agent; this last assures himself, by a summary verification, of the agreement between the load and the indications of the delivery sheet." All this appears to amount to looking at the documents issued by the refiner. If the duty were levied on the sugar going out the method would be a very different one. To show how vague the system is, the Decree goes on to say: "In case of suspicion of fraud or presumption of error, a superior officer charged with verification, or the head of the service of the refinery, may have the carts unloaded in his presence and a fresh weighing of the contents of these carts." Can anyone imagine for a moment that such a method as this would be pursued if it were a bonded warehouse with duty chargeable on delivery? In that case the excise officers and their clerks would keep their own accounts, weigh and tare the goods themselves, and debit the duty accordingly. It is clear that in the French refinery it is the refiner who keeps the accounts and the excise officer who only looks at them. The Decree continues: "At the end of the day the refiner recapitulates the indications of the delivery sheets on a printed form which the administration furnishes him with for this purpose. This printed form, in duplicate, is signed and certified by the agent of the administration and by the refiner. One is preserved by the refiner and the other by the administration."

All very pretty, but it is not refining in bond or anything like it. There is much more of the same kind. In the yearly stock-taking

"*the refiner* shall, in the course of the operations, declare the weight and analysis of all the products existing in each factory or warehouse."

There is one very remarkable Article in this Decree. We related in our former article how the French Government at one time carried out what they were pleased to call excise supervision, not by weighing the refined sugar when it left the refinery, but by examining the molasses and seeing that the quantity of sugar contained in it corresponded with the deductions established by the analysis of the raw sugar. The French Government say that they are now going to weigh the refined sugar as it goes out of the refinery. If so, there is no need to go through any such grotesque operation as has just been described. And yet we find, in Article 15, full directions for carrying out the same operation. The account is to be debited with "the quantity of sugar corresponding with the deductions allowed for salts and glucose from the polarization of the raw sugar introduced. This debit is discharged by the quantities of crystallizable sugar and glucose contained in the molasses delivered as molasses, and in the molasses of the *vergeoises*." Why is this ridiculous and impracticable substitute for weighing the deliveries of refined sugar to be retained now that they profess to adopt a most strict and thorough weighing of all sugar leaving the refinery?

This decree is full of these elaborate pretensions, but it is difficult to find any simple statement that the sugar delivered will always be sampled, weighed and tared by the Excise officials themselves. On the contrary, as our quotations show, there is every reason to suppose that the accounts will be kept entirely by the refiner and merely exhibited to the officials. If not, why should provision be made for unloading and reweighing a delivery "in case of suspicion of fraud or error?"

This decree merely emphasises the original objection to the system. If the sugar were refined *in bond* the whole refinery would be treated as a bonded warehouse, and deliveries from it would take place under the ordinary rules and conditions of a bonded warehouse. Simplicity would be substituted for this pretentious elaboration, duty would be paid only on the sugar when delivered for consumption, and all sugar destined for exportation would be shipped without claiming any drawback, and therefore without receiving any bounty.

At the Ormskirk (Lancashire) Agricultural Show, on August 27th, some of the local farmers exhibited beetroots grown by themselves. These were of a very satisfactory character. Mr. Sigmund Stein was one of the judges.

THE FUTURE FOR THE WEST INDIES.

The *West India Committee Circular* sounds a note of warning on the danger to West Indians of any continuation of a *laissez faire* policy. It rightly points out that while the Brussels Convention has put a stop to unfair competition of beet sugar, it has also given a fillip to other cane producing areas, of which the latter will not be slow to take advantage. Our contemporary says:—

"With every prospect of fair prices in the sugar market for some time to come, we cannot too strongly urge upon the West Indian proprietors the necessity for seizing the opportunity which clearances will afford of doing their utmost to strengthen their position, and that of the West Indian sugar industry generally, by improving their properties, both as regards factory and cultivation. It is too much, we are afraid, a feature of life in the tropics to deal only with the present, and to be blind, to a greater or less extent, to the progress of events in the outside world. Climate and life in the tropics are anything but favourable to the exercise of cool reason, and the glitter of profitable prices is too often taken as indicating a permanent instead of a passing condition. We do not hesitate to say that, in many instances—and we allude especially to Barbados and the smaller Islands—the occasional paying price of sugar has, during the last 20 years, actually retarded the development of the industry. The necessity for improvement seems to many to disappear with the appearance of profits, and schemes for cheapening production are dropped, or, at any rate, only kept alive in a half-hearted manner. As has been pointed out in a previous issue of the *West India Committee Circular*, the competition which the West Indies will have to face will not be that of the beet industry alone, but principally of cane from other and newer sugar-producing countries. Unless, therefore, the West Indian proprietor puts his house in order while the opportunity is presenting itself, there may be no further chance given him of doing so. A start has been made in the right direction by the erection of a small central factory in Antigua, and we cannot too strongly urge that the Barbados central factory schemes should once more be taken up and carried to a satisfactory end. It has been too much the custom, in dealing with central factories in the smaller Islands, to treat the question as being one still in the experimental stage. The lines, however, on which they should be constructed and organised are so very well known that the questions left to be decided are purely local and should admit of easy and satisfactory settlement. The Factory question is but one of the points in which the position of the sugar industry can be strengthened, and we sincerely trust that the golden opportunity which is now presenting itself will not be allowed to pass by without its being fully utilised."

THE BRITISH ASSOCIATION'S ANNUAL MEETING.

Agricultural Sub-section.

The annual meeting of the British Association was held this year at Cambridge, when the President was the Prime Minister, the Right Hon. A. J. Balfour, M.P. On this occasion a sub-section of the Botanical Section was formed to deal with agriculture. The chairman was Dr. William Somerville, and his opening address was devoted to the consideration of subjects which have received attention of late at the hands of scientific investigators. His paper (as reported in the *Times*) was as follows:—

In an introductory review, Dr. Somerville pointed out that although agriculture had only now been elevated to a position of semi-independence in the programme of this Association, it had, in the aggregate, received much attention at the meetings inaugurated with that at York in 1831. In the account of the first meeting in Cambridge in 1833 they found a report by Lindley on the Philosophy of Botany, two of the items in which were of interest to students of rural economy. Apparently at that time much attention was being given to the mode of the formation of wood. Two theories appeared to have divided botanists—the one that wood was organised in the leaves, and sent down the stem in the form of embryonic but organised fibres, to be deposited on the surface of wood already formed. The other theory was that wood was secreted *in situ* by the bark and older wood. It was to the former of these theories that Lindley gave his adherence. Although this problem had ceased to interest, the same could not be said of another subject discussed in the same report—namely, the so-called "fæcal excretions" of plants. Lindley attributed to Macaire the demonstration of the fact that all plants parted with a fæcal matter by their roots. These excretions he held to be poisonous, maintaining that, although plants generated poisonous secretions, they could not absorb them by their roots without death, concluding that "the necessity of the rotation of crops was more dependent upon the soil being poisoned than upon its being exhausted." He indicated the lines along which investigation might with advantage proceed, one of the questions put forward being "the degree in which such excretions are poisonous to the plants that yield them, or to others." The subject of harmful excretions had recently obtained renewed attention through the work being done at the Woburn Fruit Station. No point had received more striking demonstration there than the harmful influence that growing grass exerted on fruit trees. It had been shown that this prejudicial influence was not due to the withdrawal of moisture, to the

curtailment of supplies of plant food, to interference with aeration, or to modifications of temperature. In Mr. Pickering's opinion, "the exclusion of all these possible explanations drives us to believe that the cause of the action of grass is due to some directly poisonous action which it exerts on the trees, possibly through the intervention of bacteria, or possibly taking place more directly." It was satisfactory to know that the subject, which was of considerable scientific and practical importance, was likely to be vigorously followed up.

Artificial Manures.

In the early forties attention was being directed to a subject that even now had a great attraction for agriculturists—namely, the stimulating and exhausting effect of artificial manures, especially nitrate of soda. Daubeny suggested that manuring should be undertaken on a system of bookkeeping—on the one side being entered all the items of plant food taken out by crops, and on the other all that applied in the form of manures, the two sides of the account being made to balance. This theory of manuring was distinctly suggestive, and often fitted in rather remarkably with actual practice. But they now knew that much of the plant food offered in manure never entered the crop at all, so that the balancing of the account was due almost as much to chance as to calculation. During the fifties the volumes of the association contained several important contributions from the two distinguished Englishmen to whom the world's agriculture owed so much, Lawes and Gilbert. Their first contribution was made in 1851, and dealt with Liebig's mineral theory. They drew upon their rich store of experimental *data* to prove that the yield of wheat was much more influenced by ammonia than by minerals, and they gave it as their deliberate opinion that the analysis of the crop was no direct guide whatever as to the nature of the manure required to be provided in the ordinary course of agriculture. Field experiments or demonstrations, which had been such a prominent feature of the educational work of the past decade, appeared to have been first introduced at the meeting of the Association in 1861 by Dr. Voelcker. While agricultural subjects had claimed a considerable share of the time of the Association, forestry had not been altogether overlooked. As early as 1838 they found attention being directed to what of recent years had come to be a burning question—namely, the maintenance of our timber supplies. Captain Cook estimated that "100,000 acres of waste taken from the Grampian Hills for the growth of larch would in two generations not only supply the ordinary wants of the country, but enable us to export timber." Assuming a rotation of 80 years, this estimate postulated that the produce of some 1,200 acres, of a value of about £120,000, was sufficient to make us independent of foreign supplies. Such was the estimate of 1838. In 1904 Dr. Schlich, in his volume

on "Forestry in the United Kingdom," after making allowance for woods like mahogany, teak, &c., which could not be grown here, came to the conclusion that "if all these items are added up we find that we now pay for imports in timber . . . . the sum of £27,000,000, all of which could be produced in this country." Assuming as before that the value of an acre of mature forest was £100, this meant that our imports were drawn from 270,000 acres, and to maintain our supplies merely at their present level a forest area of more than 20,000,000 acres, worked on an 80 years' rotation, was necessary.

Farmyard Manure.

Those who had followed the progress of agricultural science in Germany must have noticed how much attention had been given during the past ten years to investigating the changes that took place in farmyard manure during storage under varying conditions. The stimulus and funds for this work had for the most part been supplied by the German Agricultural Society, which in 1892 resolved to carry through an exhaustive inquiry. For this purpose it enlisted the co-operation of several of the most fully equipped stations in the empire, and the reports that had appeared bore testimony to the industry and analytical ingenuity that had been brought to bear on this important subject. The experiments were originally designed to extend over four years, the first, 1892-93, being devoted to preliminary, chiefly laboratory, experiments; the others to work on a scale more in accordance with farm practice. The subject had been found to bristle with difficulties, and the results obtained with small quantities of manure, or in summer, had not always been confirmed with large quantities of manure, or in winter. In 1897 he published an account of the more important results obtained up to that time, confining himself chiefly to questions of temperature and the loss of organic matter, and the conclusion arrived at was that "none of the conservation agents usually employed appears to have any very important influence on the decomposition of farmyard manure." Since then several important reports had appeared. The general conclusion arrived at, and clearly expressed by Pfeiffer, was that excessive loss in manure could be best avoided by storing it in a deep mass in a water-tight dungstead placed in a well-shaded situation, in which the material was firmly compressed. The necessary compression could be secured in various ways, perhaps most conveniently and effectively by the means of the treading of cattle. The use of a considerable proportion of moss-litter was strongly recommended. This substance not only absorbed and retained the liquids, but, being acid, it fixed ammonia. In the absence of moss-litter, loamy soil rich in humus would prove a useful substitute.

Chemical Fixation of Atmospheric Nitrogen.

It had for long been the dream of chemists to discover, or welcome the discovery of, a chemical process, capable of industrial application, by which the nitrogen of the air could be made available to replace or to supplement the rather limited supplies of nitrogenous manures. Sir William Crookes looked hopefully to electricity to solve the problem. He pointed out that with current costing one-third of a penny per Board of Trade unit a ton of nitrate of soda could be produced for £26; while at a cost of one-seventeenth of a penny per unit—a rate possible when large natural sources of power, like Niagara, were available—the cost of such artificial nitrate of soda need not be more than £5 per ton. Dr. von Lepel, in giving an account of recent work on this subject to the winter meeting of the German Agricultural Society in February of this year, put the cost of electric nitrate, as compared with Chile nitrate, in the proportion of 24 to 39. Good progress would also appear to have been made in another direction in the commercial fixation of atmospheric nitrogen, and a short account of the results was communicated by Professor Gerlach, of Posen, to the meeting of the German Agricultural Society already referred to, and was published in the same issue of the "Mittheilungen." So far as one might judge from the information available, it would appear that agriculture would not have long to wait till it was placed in the possession of new supplies of that most powerful agent of production, nitrogen, and Sir William Crookes would see the fulfilment of his prediction that "the future can take care of itself."

Nitragin.

A few years ago much interest was excited in this and other countries by the announcement that the scientific discoveries of Hellriegel and Wilfarth had received commercial application, and that the organisms of the nodules of the roots of Leguminosae could be purchased in a form convenient for artificial inoculation. The specific cultures placed upon the market were largely tested practically and experimentally, but the results were such as to convince even the patentees, Nobbe and Hiltner, that the problem which promised so much for agriculture had not been satisfactorily solved. Since that time, however, investigators had not been idle, and the present position of the subject was to be found in a recent report by Hiltner and Störmer. The nitragin put on the market a few years ago was used in two ways, being either applied directly to the fields, or mixed with water and brought into contact with the seed before sowing. Under the former method of procedure an increase of crop was obtained only when the nitragin was used on land containing much humus. The explanation given for failure under other conditions

was that the bacteria artificially introduced perished for want of food before the leguminous seed germinated and produced plants. Failure of the nitragin to effect an improvement in the crop when it was sprinkled on the seed was now believed to be due to the action of secretions produced by the seed in the early stages of germination. This difficulty was found to be got over by moistening the seed and allowing it to sprout before the nitragin was applied; but manifestly such a procedure would always be difficult, and often impossible, to carry out in practice. The object, however, would appear to have been gained in another way—namely, by cultivating the bacteria in a medium that imparted to them the necessary power of resistance. Such nourishment might take various forms, but that which gave the best results consisted of a mixture of skim milk, grape sugar, and pepton, and it was in this medium that the organisms of the nitragin now distributed were cultivated.

Improvement of Varieties of Crops.

Speaking generally, the attention of agricultural investigators during the past 50 years had been directed more to manurial and similar problems than to the improvement of the yield of crops through the agency of superior varieties. This, it seemed to him, was the outcome of the tradition that agricultural science was based upon chemistry, using the term in its old-fashioned and restricted sense, and as a consequence farmers had looked principally to the chemical laboratory for light and leading. It was true that much excellent work had been accomplished from the botanical side, but this had been performed rather by farmers, seedsmen, or amateurs than by trained botanists. But fortunately the botanist was now getting his opportunity, and the possibilities before him were sufficiently attractive. Judging by the results that had been obtained, it would appear that wide divergencies as regards yield, nutritive qualities, resistance to disease, and other important properties existed between varieties of the same plant-species; so much so, that attention to the relationship between variety and locality would appear to one of the most important matters to which a farmer could give consideration. But it had been found that new varieties were frequently unstable, reverting rather rapidly to an unsatisfactory form, or displaying a lack of power of resistance to disease. It therefore became necessary constantly to be producing new varieties to take the place of those that were worn out, and it seemed reasonable to anticipate that the professional botanist would take a much larger part in this work than had been the case in the past. Not only was the yield of a crop greatly influenced as regards quantity and quality by the variety of seed employed, but, as was well known to practical farmers, the local origin of the same variety of seed had a marked influence on many properties of plants (vigour, resistance to disease, and

resistance to frost, and to weather generally), and these properties quickly reacted on the yield.

JOINT OR CO-OPERATIVE WORK.

In conclusion, he urged that it was by systematised co-operative effort that the practical value of an idea was tested, and that the knowledge was made available and acceptable to the workaday farmer. Various objections had been urged against field experiments, and it need not be denied that they were incapable of supplying a satisfactory answer to many scientific questions. Such experiments were exposed in no small degree to the disturbing influences of inequalities of soil, irregular cultivation, the attack of animals, and the vicissitudes of climate; but when reasonable precautions were taken to guard against these, and given a sufficient number of tests, the results of field trials were of the highest value as a guide to practice. Apart from attention to the preliminary details of the scheme, and to care in carrying it out, the main point to aim at in field trials was to have them so frequently duplicated or repeated that the disturbing factors inseparable from field work would be largely eliminated. One of the largest and most successful agencies in co-operative demonstrations was to be found in Canada, where, during the past nine years, an average of 37,000 farmers had annually received small parcels of improved seeds through the Government experimental organization directed by Dr. Saunders. It was claimed that the financial results to the country as a whole ran to many millions of dollars, and there seemed to be no reasonable doubt as to the accuracy of the statement. In his opinion one of the best pieces of work that had been done in this country in recent years was the preparation of the scheme of joint experiments by the Agricultural Education Association. The problems set for solution under that scheme were of the simple, direct, practical kind that field work was thoroughly qualified to deal with. But the essence of success lay in the power of numbers, and the control of this factor rested with the members of the association themselves. Most of the members of that association were not only investigators but also teachers, and many of the institutions that they represented had recognised the advantages of keeping in touch with their past pupils through the agency of collegiate associations. These old students, it seemed to him, represented a large mass of most valuable material for carrying through co-operative experimental work of the class referred to, and he was convinced that the agriculture of the country would benefit in no small degree were this powerful agency fully utilized.

In Madagascar, a tax of 15 fr. per hectare is levied on all land on which sugar is grown.

SCIENCE IN SUGAR PRODUCTION.

By T. H. P. Heriot, F.C.S.

(Continued from page 371.)

4. Manufacture.—(*Continued.*)

(c) Concentration of the Juice to Syrup.

In the preceding stages of manufacture we have shown how differences in the physical structure of the raw materials, or in the chemical composition of the extracted juices, have led to different methods of treatment in the two industries; in the operations which follow, these peculiarities practically disappear.

As the preliminary chemical treatment of the juice has for its object the separation of impurities without influencing the dissolved sugar, we have now to examine the more essential operation of extracting dry sugar from the purified liquid by evaporating the solvent, water. In modern practice it is found convenient to conduct the evaporation in two stages; the dilute juice being first reduced to about one-third its volume of syrup containing some 50% of water in which the whole of the sugar remains dissolved, and, secondly, the syrup is concentrated to a semi-solid mass containing only from 5 to 8% of water.

In the present paper we proceed to review the methods and appliances employed for concentrating juice to the state of syrup, and to show that this apparently simple operation requires to be conducted on scientific principles.

The continuous boiling of the juice is, unfortunately, accompanied by certain changes in the dissolved solid matters, which may first be briefly considered.

Inversion.—Perfectly dry sucrose can be heated, without decomposition, at temperatures considerably above 100° C, but, in the presence of water, 95 parts of the former slowly combine with five of the latter to form 100 parts of uncrystallisable sugar called glucose; this change, known as "inversion," is proportional to the temperature and duration of the heating. Although comparatively slight in the case of pure solutions of sugar, it is greatly facilitated by the presence of free acids and certain salts.

Coloration.—Simultaneously with the formation of invert sugar, the juice, or syrup, darkens in colour during prolonged heating owing to the action of lime on glucose, and, unless special precautions are taken to prevent overheating, the sucrose itself becomes decomposed with the formation of caramel.

Precipitation.—Certain lime salts, and other mineral substances, present in the purified juice, become insoluble when the liquid is

concentrated, so that the resulting syrup is invariably turbid and can only be rendered bright and clear by filtration.

The Cane.

Direct Heat.—Before the application of steam as a source of heat the juice was boiled in shallow vessels heated from below by a naked fire. In the "Copperwall" the furnace is connected to a chimney by a brick flue supporting a line of four or five copper pans built into the masonry, so that their bottoms project into the flue. These pans were sometimes of uniform size, but, more generally, of diminishing capacities, the smallest pan or "striking teache" being situated directly over the furnace. The latter was fired with sun-dried megass and wood, and the flames, passing to the chimney, were thus brought into contact with the bottoms of the coppers. Dilute juice entered the pan furthest from the furnace, was partially evaporated, and transferred by a ladle to the second pan, and so on, each pan being supplied from the preceding one, and all boiling simultaneously. The juice supplied to the first pan was thus gradually brought to a state of syrup in the last at a temperature of about 240° F.

Of the total heat evolved by the fuel, the greater part escaped up the chimney, another portion being absorbed by the brickwork, and only a small balance remained available for heating the coppers. But this residue of useful heat was generally excessive and heated the coppers to a much higher temperature than their contents, causing serious destruction of sugar by local overheating. Formerly, the syrup was by inversion must have been ruinous. Formerly, the syrup was further evaporated to the final, or crystallising point, before being removed from the striking teache, but, with the advent of the "vacuum pan" (to be shortly described) the copperwall was solely employed for the concentration of the juice to syrup, the latter being then boiled at a lower temperature by means of steam.

As a method of evaporation the old copper-wall hardly merits description, but for its historical interest and the extreme reluctance with which the planters have abandoned its use. It is not to the credit of the West Indian industry that this wasteful system of evaporation may still be met with, although, happily, the larger factories have profited by the more scientific methods adopted in the rival industry. These methods must therefore be described under the following section.

The Beet.

Direct Heat.—For a period of over 30 years the beet industry adhered to the method of evaporation described above, and at a greater disadvantage, because the refuse from the beet could not serve as fuel, consequently, some 40 odd tons of coal had to be burnt in order to extract eight tons of sugar from 100 tons of roots, and beetroot sugar was a luxury which only the rich could afford.

High Pressure Steam.—Whilst the industry was yet in its infancy—there being only 60 French factories in actual operation—the idea of evaporating juice by means of steam-heat was independently proposed by two French engineers, M.M. Moulfarine and Pecquer, in the year 1828, their idea being to heat the juice indirectly by burning the fuel under a steam boiler, in which the heat value of the fuel could be much better utilized than when directly applied under the evaporating pans. The steam was conveyed from the boiler by pipes terminating in coils or grills immersed in the juice in the evaporating pans. By this means the heat absorbed from the fuel by the boiler is locked up or rendered latent in the steam until the latter, by condensation in the coils, yields up its heat to the juice and returns to the boiler in the form of condensed water. Such coils form heating surfaces because the latent heat of the steam is conducted across the intervening metal wall of the coil, which heats the evaporating liquid in contact with its external surface.

With the old type of boiler then in use the coal consumption was thus reduced by one half, namely, about 20 tons per 100 tons of roots worked. But even with a good boiler it is only possible to utilize about two-thirds of the total heat evolved by the fuel, the balance being lost in the flue gases escaping up the chimney, by radiation, faulty stoking, etc.

Multiple Effect Evaporation under Pressure.—In 1829 Pecquer conceived a more economical system of evaporation, involving a novel principle, which consisted in utilizing the influence of pressure on the temperatures at which liquids boil in order to multiply the efficiency of a given weight of fuel. To explain the practical application of Pecquer's system we will take the simplest case of the evaporation of pure water in two boilers (double effect). Instead of heating each boiler by a separate furnace, he applied direct fire to one only, and heated the second boiler by the steam produced from the first. For this purpose the lower part of the second boiler was fitted with a tubular heating surface into which steam was conveyed from the first boiler by means of a pipe. His second boiler was an open evaporator in which the water boiled at 212° F., whereas the first was closed in such a manner that the steam could only escape into the heating chamber of the second. Under these conditions the steam produced in the first vessel heats the water in the second, but in order that the water in the latter should be kept at the boiling point, it is essential that the steam coming from the first should have a higher temperature than 212° F. This is effected in Pecquer's system because the condensation of the steam from the first boiler becomes less perfect in proportion as the temperature of the water in the second approaches the boiling point. There remains, therefore, some uncondensed vapour which exerts its pressure upon the water in the first boiler,

the effect of this pressure being to raise the boiling point of the water and the temperature of the steam passing to the second boiler. Hence, in Pecquer's double effect we find the water boils at 212° F. in the second vessel (working at normal atmospheric pressure), but at, say, 249° F. in the second, which we will assume to work at a pressure of two atmospheres.

The advantages of this system are much more obvious in the case of triple- and quadruple-effects. In the latter, for example, we find four boilers arranged in a continuous series, the liquid in each being boiled simultaneously by directly heating only the first, the evaporating power of the fuel (or of high-pressure steam) is therefore utilized four times over. The last vessel, as before, boils under the normal atmospheric pressure but in each of the preceding vessels the pressures and boiling points increase progressively. Supposing water to be the liquid evaporated, and that between each vessel there is a difference of pressure equal to one atmosphere, the water in each vessel would then boil at the following temperatures:—

	First.	Second.	Third.	Fourth.
Degrees F.	291 ..	273 ..	249 ..	212

Although admirably adapted to the concentration of various liquids and solutions, Pecquer's system is not applicable to the evaporation of saccharine juices because sugar is readily destroyed at such high temperatures. Before following up the history of multiple-effect evaporation, we must here briefly refer to another important invention.

Evaporation in Vacuo.—Our present method of evaporation at low temperatures owes its origin to a patent taken out in 1813 by the Hon. Edward Charles Howard, and the theory of his vacuum pan must now be considered. The temperature at which any given liquid boils in an open vessel is that at which the expansive force of its vapour is equal to the external atmospheric pressure of 15 lbs. per square inch. The boiling point is *raised* when this pressure is *exceeded* by confining the vapour in a boiler, but may similarly be *lowered* when the normal pressure is *reduced* by removing the atmospheric pressure, or producing a vacuum.

The following figures illustrate the variability of the boiling point of water:—

Pressure in Atmospheres.		Boiling Point.
10	Plus Pressures	356° F.
5	Plus Pressures	306° ,,
1	Normal ,,	212° ,,
$\frac{1}{4}$	Minus ,,	151° ,,
$\frac{1}{76}$	Minus ,,	50° ,,

Howard's apparatus consisted of a closed pan having a double bottom, or steam chamber, for heating the contents. The vapour and air are carried off, from a dome at the top of the pan, by a vapour pipe connected with an air pump. A cold water injection apparatus condensed the steam rising from the pan, so that a continuous vacuum could be maintained during boiling.

This valuable invention was for many years exclusively employed in sugar refineries in this country, not being applied to the evaporation of beet juice until about 1830. The beet fabricants long objected to its use because it required a steam engine to work the air pump, and steam engines being at that time unfamiliar objects on the Continent, were branded as dangerous! Curiously enough, they had long employed steam boilers without any qualms, ignorantly believing that the engine, not the boiler, was liable to explode.

The low temperatures at which liquids boil in vacuo has since rendered the vacuum pan an invaluable appliance in every sugar factory and refinery, and will be again referred to in our next paper. Regarded simply as an exaporator, it fails to effect any considerable economy of fuel, and we therefore proceed to

Multiple Effect Evaporation in Vacuo.—At this period (1830) a young French engineer, Rillieux, attacked the problem of evaporating beet juice. Adopting Pecquer's multiple effect system and Howard's invention, he avoided the defects of the former by removing the atmospheric presure from the last vessel, replacing Pecquer's open evaporator by Howard's vacuum pan. The effect of this simple alteration will readily be seen in the case of a double-effect.

The second vessel of this combination is connected directly to a cold-water condenser and an air pump; the liquid to be evaporated will therefore boil at a very low temperature, proportional to the vacuum maintained. The required temperature is supplied to the heating surface by steam produced in the first vessel, which is thereby condensed to water at the same temperature. But as the latter is higher than that of the condenser to the second vessel, condensation in the first is less perfect, so that a difference of pressure and of temperature arises between the two vessels; an essential condition for multiple effect evaporation, as already stated.

But it is of special interest to note that the pressure existing in the first vessel, although higher than that in the second, is considerably less than the normal atmospheric pressure because the temperature of its condenser (*i.e.*, the second vessel) is lower than the boiling point of water at atmospheric pressure. Hence it follows that a partial vacuum is formed in the first vessel and a more perfect vacuum in the second; the juice is evaporated in both vessels at a low temperature; and it is further only necessary to heat the first vessel with low-pressure steam.

In this manner Rillieux succeeded in combining the economical advantage of Pecquer's system with the ideal conditions, as regards temperature, devised by Howard.

To his double-effect apparatus, he added another unit, forming the first vessel of a triple-effect evaporater, in which the vacuum formed in the third was distributed between the three, and the evaporating power of the steam, applied to the first, was utilized three times over.

Unable to find a beet fabricant in France of sufficient intelligence to understand and appreciate the value of his invention, Rillieux sailed for America, and, after many disappointments, met with a cane planter in Louisiana who agreed to give his evaporator a trial. This was in 1845, or some 15 years after his ideas had been realised on paper.

In 1852 his apparatus found its way into the beet factories of Europe where Howard's vacuum pan was already installed. These two improvements reduced the consumption of fuel from 20 to 12 tons of coal per 100 tons of beets worked, whilst the extensive use of steam engines in the factory constituted a no less important factor in reducing the general cost of manufacture.

The fact that these engines liberated a large quantity of exhaust or low-pressure steam did not escape Rillieux's notice, and he utilized it in the first vessel of his evaporator, thus effecting the evaporation of the juice by means of steam which had hitherto been completely lost.

There is no theoretical limit to the number of vessels which may be combined in one multiple-effect, but the economy of fuel resulting from the addition of each successive unit to the triple-effect (forming quadruple, quintuple-effects, etc.,) diminishes rapidly, so that a practical limit is reached when the cost of an additional vessel fails to be remunerative.

In 1882 Rillieux went further and applied the economical principle of his evaporator in other departments of the factory, namely, for heating the juice during diffusion and carbonatation, also the syrup before filtration. Up to that time these operations consumed a large proportion of high-pressure steam supplied directly from the boilers, although the actual temperatures required could be equally well obtained by a sufficient supply of exhaust or low-pressure steam. Rillieux increased the size of the first vessel of his evaporator in order that the juice boiled therein might furnish sufficient low-pressure steam for the "outside" operations just referred to, in addition to that required for boiling the juice in the second vessel. By this plan the heating of the juice at the diffusion battery, carbonatation tanks, etc., is a "secondary effect" of steam applied directly to the first vessel of the evaporator, wherein the evaporation of an equal weight of water from the juice in the first vessel was the "primary effect."

Similarly, in operations requiring a lower temperature, as in the first carbonatation, steam from the second vessel was also utilized. In this case, the heat applied directly to the first vessel was used twice for evaporating juice (in the first and second vessels) before the final or third application at the carbonatation tanks, the juice being thus heated by triple-effect with great economy.

These advantages are gained without any reduction in the efficiency of the multiple-effect evaporation, it being only necessary to construct the vessels with sufficient heating surface to furnish the additional quantity of steam required.

To illustrate the value of Rillieux's perfected system, we reproduce the following data from Horsin Deon, representing the weight of steam required in various operations of a beet factory for every 10 gallons of juice treated:—

	Pounds.	
Diffusion	8	29 pounds
First Carbonatation	14	
Second ,, ...	6	
Heating syrup before filtration	1	
Evaporation of 80 lbs. of water by triple effect	30	
Boiling syrup to crystallising point ...	8	
Centrifugals, losses, &c.	10	
Total	77	

Now, if the 29 pounds of steam required in the first four operations are furnished by the *juice* boiled in the first vessel of the triple effect, the subsequent item for evaporation is proportionately reduced, because the said 29 pounds of steam represent the same weight of water already evaporated. Instead of 80 pounds of water requiring 30 pounds of direct steam, we now have only 51 pounds to evaporate, requiring 20 pounds of steam, thus saving 13% of the total.

Replacing the triple by the quadruple-effect, and utilizing the vapour from the first and second vessels, the total steam required is reduced to 54 pounds, or an economy of 30% over and above that due to triple effect evaporation, reducing the consumption of coal from 12 to 8 tons per 100 tons of beet worked up.

To fully appreciate the progress made in 60 years in this one department of the beet industry, it is necessary to take into consideration the larger volume of juice obtained by diffusion from the same weight of roots. Whereas, in 1825, it was only possible to extract about 200 gallons of juice from a ton of beets, almost double that volume is now obtained in the diffusion process. Had this volume to be treated by the wasteful methods of heating by direct fire employed in 1825, the coal consumption would have mounted to 75 tons where 8 now suffice!

As designed by Rillieux, the evaporating vessels were given the form of locomotive boilers but this horizontol type has certain practical inconveniences so that vertical vessels have now become general. Since 1828 no radical change has been made in the working of multiple-effect evaporators although numerous modifications in the details of construction have been patented from time to time. Such minor improvements may be grouped under the following heads:—

(a.) The perfect circulation of the juice during evaporation.

(b.) The distribution of the steam over the heating surfaces of each vessel and the rapid removal of water of condensation.

(c.) The prevention of entrainment; that is, the loss of sugar in small drops of liquid carried away by the upward current of vapour from the boiling juice.

(d.) The prevention of incrustation on the heating surfaces caused by the precipitation of mineral matters rendered insoluble during the concentration of the juice to syrup.

We must, however, refer to one improvement of special interest which relates to the area of the liquid surface from which evaporation takes place. It will be obvious that when the metallic heating surface is immersed in a large mass of juice, it is in actual contact, at any given moment, with a relatively small area of liquid so that the steam evolved from the latter has to force its way upwards through a variable depth of juice, which impedes its escape, and thus diminishes the possible efficiency of the apparatus. This defect has been remedied by what it known as "film evaporation," which consists in causing the juice to flow over the heating surfaces in a thin stream, allowing the free escape of vapour as fast as it is produced. The surface area of the juice undergoing evaporation is also increased enormously, being approximately equal to the area of the heating surface, instead of being limited to the area of a horizontal cross-section of the containing vessel.

The first patent for film evaporation on the multiple system was taken out by Lillie, in America, but caused little stir. Each vessel was of the vertical type, the tubular heating surface being so arranged that all the tubes opened into the upper and lower parts of the vessel. The juice to be evaporated was supplied in a constant stream above an horizontal plate from which the open tops of the heating tubes slightly projected. By this arrangement the juice is caused to overflow into the tubes, and to flow as films down their interior surfaces whilst being heated by the steam applied outside the tubes. Arriving at the lower extremity, the juice falls from the tubes as a spray to the bottom of the vessel from which a pump elevates it to the top of the next vessel, or returns a portion to the top of the same vessel.

Another American, Yaryan, adopted the horizontal type of vessel, in which film evaporation was brought about by forcing the liquid into the heating tubes through nozzles of relatively small diameter, so that the interior surfaces of the tubes are covered by a fine spray which evaporates spontaneously. The spray and steam travel through the tubes and impinge upon baffle plates, which separate and retain the liquid, but allow the vapour to pass to the heating chambers of the next vessel.

Lillie has since invented a much more perfect arrangement, generally considered as the ideal type, and which is applicable to single, as well as to multiple-effect evaporation. The vessels are horizontal cylinders, fitted with horizontal heating tubes, *through* which the *heating-steam* circulates whilst the liquid is evaporated as a film on the exterior surfaces of the tubes, thus reversing the direction in which the heat is transferred through the metal of the tubes. Small centrifugal pumps under each vessel maintain a constant spray of liquid over the heating tubes by drawing partially-evaporated liquid from the bottom of each vessel, and returning same to a distributer at the top. The juice is drawn from vessel to vessel as in other types of effects. The final syrup is withdrawn at intervals from the last vessel by means of a clever automatic device which operates only when the desired density has been reached. Quadruple effects on the Lillie model have been constructed to evaporate 75% of water from 500,000 gallons of juice in 24 hours.

The Cane (continued.)

The cane industry is the happy possessor of a supply of natural fuel which, with the adoption of modern methods, has proved amply sufficient for furnishing the factory with steam. But, at the period at which we must resume our history, namely, the days of open evaporation over the naked fire, the crushed cane had to be most carefully dried in the sun, a large number of hands being daily told off to this task. Even then the copperwall called for more fuel in the shape of wood or bamboo.

So long as profits were certain little, if any, interest was taken in the progress of the rival industry; but one day the West Indian proprietors woke up to find their valuable estates yielding diminishing returns, and something had to be done.

The proposal to adopt multiple-effect evaporation met with the strongest opposition on the part of the planters, some of whom, never having seen the apparatus, declared that it was not suited to cane juice, or could not be worked in a tropical climate! This prejudice was not overcome until some thirty years after this valuable invention had been widely adopted by their beet rivals.

At the present day there are few factories which do not boast a triple-effect evaporator. The "Yaryan" has been tried and

found wanting, but the improved "Lillie" has given perfect satisfaction wherever adopted.

We are once more obliged to limit our review to general principles and their historical connection, but the enquiring reader will find illustrated descriptions of the various evaporators in text-books. If engaged in the sugar industry, he should avail himself of the opportunity of studying the theory and practical working of these wonderful appliances.

(To be continued.)

DISEASES OF THE SUGAR CANE.

The Imperial Department of Agriculture for the West Indies have added another to their list of pamphlets by publishing the substance of three lectures* recently delivered before the members of the Barbados General Agricultural Society, on some fungoid diseases of the sugar cane, by Mr. L. Lewton-Brain, B.A., the mycologist of the Imperial Department.

This subject has often been treated on in our columns from time to time, but has generally been written from a technical standpoint. These lectures on the other hand were delivered on a popular basis, and, containing less abstruse matter and scientific detail, were more calculated to be appreciated by the ordinary planter whose working staff does not include an agricultural expert. The subject dealt with in the lectures included: the external features and internal structure of the sugar cane; its nutrition; the structure, nutrition, and reproduction of fungus; and finally the "rind" and "root" diseases and the question of their eradication.

The diseases referred to attack canes to a greater or less extent in all the sugar-producing colonies in the West Indies. The root disease (*Marasmius*) was especially prevalent at Barbados last year, and it was largely due to the attacks of this fungus that the sugar crop of 1903 (35,000 hhds.) was lower than any during a period of thirty-four years. It was even lower than in 1895, when the ravages of the rind fungus (*Trichosphaeria*) reduced the normal crop of 56,000 hhds. to 36,000 hhds. and led to the practical abandonment of the Bourbon cane. The principal canes now cultivated are the White Transparent and seedling canes.

A conservative estimate, after making every allowance for unfavourable seasons and other circumstances, has placed the loss due to the attacks of fungoid diseases at Barbados during 1903 at 10,000 hhds. of the value of £70,000. If we take into account the loss

* This pamphlet can be procured from the Imperial Department, Barbados, or their agents. Post free 5d.

sustained in molasses also, the total loss in 1903 would not fall far short of £100,000. It was with the view of aiding the planter to control the diseases affecting his crops, especially in these days of low prices, that the lectures delivered by Mr. Lewton-Brain were organized. If the advice given in the lectures be closely followed, there is little doubt that the loss likely to be sustained from the attacks of cane diseases might be reduced at least one-half. It is hoped, in view of these facts, that the recommendations of the Department will receive the hearty support of all members of the planting community.

Rind disease.—The spores of the rind fungus enter the cane at a wound. They germinate, putting out hyphae which enter first the thin-walled cells containing stored sugar. The hyphae afterwards enter the wood vessels and intercept the water current, so preventing the leaves from obtaining the water and mineral salts, which are necessary for the proper performance of leaf functions. The spores of the fungus are formed in immense numbers under the rind of the cane; this is finally broken through and a mass of spores emerge, all cemented together.

All rotton canes should be destroyed; boring insects, which produce wounds, should be got rid of; only perfectly healthy cuttings should be used for planting; the best cultural methods should be pursued. At present the rind disease is largely kept under by the use of resistant varieties of cane, which have, in Barbados, to a great extent replaced the Bourbon.

Pine-apple disease.—The pine-apple disease attacks cuttings and prevents their proper development. It is more abundant in a dry than in a wet planting season. Experiments, on a small scale, seem to show that dipping the cuttings in Bordeaux mixture and then tarring the ends will prevent infection.

Root disease.—The root disease is caused by a fungus *Marasmius sacchari*, which enters into, and destroys, the growing point of the root tip. The fungus is capable of existing as a saprophyte, and the mycelium is found on dead and dying parts of the cane plant, as well as on decaying vegetable matter in the soil.

The leaves of attacked plants dry up, first at the tip and edges; the dry leaf sheaths, at the base of the plant, do not fall off clean, but remain attached to the stem and matted together; the canes are dwarfed, and are easily up-rooted. The fungus produces small, white toad-stools near the ground, in wet weather; on these are born the spores of *Marasmius*. The fungus spreads by the spores, and to a greater extent by its mycelium which grows underground from one cane to another.

The root fungus is not able to do much damage to a cane plant which is growing vigorously, under favourable conditions; it waits

for an opportunity when the conditions are unfavourable to root development; this usually occurs when the plant canes are cut back and allowed to ratoon.

Very careful attention should be paid to cultivation, so that the soil conditions may be as favourable as possible to root development; a small diseased area should be isolated by a trench, 12 to 18 inches deep, which should include one or two rows of apparently healthy canes; the strictest attention should be given to the selection of "plants" and "tops," these should never be taken from an infected cane plant or even from an infected field; all infected cane stumps should be burnt or buried with lime; the greatest care should be taken than no infected trash is ever used on a cane field; canes infected with root disease should not be allowed to ratoon; badly infested land should be rested, for two or three years, from cane. There is a possibility of raising resistant varieties of cane, and special attention is being devoted by the Imperial Department of Agriculture towards this end.

CHEMICAL CONTROL IN USE IN THE JAVA SUGAR FACTORIES.*

By H. C. Prinsen Geerligs.

Director of the West Java Sugar Experiment Station at Pekalongan.

(Continued from page 388.)

II.—Calculations.

In order to simplify the formulæ which will be used here I suggest the following abreviations:—

w.c.—Weight of the cane crushed.
w.b.—Weight of the bagasse.
w.j.—Weight of the mixed juice.
w.s.i.—Weight of sucrose indicated in juice.
s. extracted on 100 cane.—Sucrose in juice on 100 parts of cane.
s.c.—Sucrose in 100 parts of cane.
s.b.—Sucrose in 100 parts of bagasse.
s.b. on 100 cane.—Sucrose lost in bagasse on 100 parts of cane.
s.f.m.j.—Sucrose on 100 parts of first mill juice.
s.m.j.—Sucrose on 100 parts of mixed juice.
f.c.—Fibre on 100 parts of cane.
f.b.—Fibre on 100 parts of bagasse.
b.—Brix of the first mill juice.
b.i.—Brix of the mixed juice.
a.s.—Available sugar.

1. Sucrose on 100 Parts of Cane (*s.c.*).

The direct estimation of sucrose in cane cannot give reliable figures, owing to the nature of the cane, which makes a correct sampling impossible. Therefore we assume a factor with which the sucrose content of the first mill juice ought to be multiplied in order to yield the average sucrose content of the cane. Usually this factor is 0·85, and does not vary much beyond 0·84 and 0·86. In single cases, when the cane contains an extraordinarily high amount of fibre, the difference is a little more. Larger deviations are due to incorrect weighing of cane, or measuring of juice, or to wrong analysis. They are a hint that something is wrong and wants rectifying.

The best method is to start with the factor 0·85, and after the first monthly or half-monthly report which shows the figures for sucrose content of cane and first mill juice, it will become apparent which figure must be used for the future.

If, however, it is thought necessary to determine the factor directly, weigh exactly 10 to 15 tons of cane, crush them in the factory mill, analyse the first mill juice, collect and weigh the resulting bagasse and determine its sucrose content. The weight and the sucrose content of the bagasse are known, and, therefore, also the weight of sucrose lost in the bagasse. The difference between the weight of the cane and that of the bagasse represents the weight of the juice, whilst its sucrose content is equally known. We calculate the weight of the sucrose of the juice, add that to the weight of sucrose in the bagasse, and so find the weight of the sucrose in the weight of canes crushed, and can calculate the sucrose content on 100 parts of cane. We know the sucrose content of the first mill juice, and thus can calculate the factor which we want.

The figure for the sucrose content of the cane thus calculated is only an average one, and by no means rigorously accurate. It is, therefore, not available as a basis for chemical control, but only serves to show day by day, approximately, how much cane has been crushed in the preceding 24 hours. This figure and its derivates may not be used in later reports than this daily one. The formula is:—

$$s.c. = s.f.m.j. \times \text{Factor.}$$

2. Sucrose Lost in Bagasse on 100 Parts of Cane (*s.b. on 100 cane*).

This figure is derived from the fibre content of cane and bagasse and the sucrose of the latter. It is not absolutely right, since we assume that no fibre is carried along with the juice. We content ourselves with calculating how much sucrose is lost on one part of fibre, and next find from the fibre content of the cane the amount of sucrose lost on so much fibre as is equivalent to 100 cane according to the formula:—

$$f.b. : s.b. = f.c. : x \qquad x \text{ or } s.b. \text{ on } 100 \text{ cane} = \frac{s.b.\ f.c.}{f.b.}$$

3. Sucrose in Juice on 100 Cane (*s. extracted on 100 c.*).

Subtract the figure for sucrose lost in bagasse on 100 cane from the sucrose content of the cane. As we showed that the figure for the sucrose in the cane is only an approximative one, the figure for sucrose extracted on 100 cane is neither absolutely accurate, and will in the final reports be replaced by a more reliable one. The formula is:—

$$s. \textit{ extracted on 100 cane} = s.c. - s.b. \textit{ on 100 cane.}$$

4. Weight of Sucrose Indicated in Juice (*w.s.i.*).

This figure representing the weight of sucrose entering in juice into the manufacture is the basis of the control, and therefore must be determined every day with the utmost care. Reliable weighing machines are as yet not invented, and we are compelled to have recourse to the old measuring tanks. It is important that these tanks be well graduated, and that the layer of foam on the surface of the juice and the expansion of material owing to the high temperature of the juice be well taken into account. Further, great care must be taken that the tanks always get well filled and their number accurately stated. Finally the sampling and the analysis of of the mixed juice require the continual supervision of the man in charge.

Multiply the weight of the mixed juice with its sucrose content and divide by 100 in order to find the weight of sucrose entering in the juice into the factory, after the formula:—

$$w.s.i. = w.j. \times \frac{s.m.j.}{100}$$

5. Weight of Available Sugar (*a.s.*).

This figure should also be calculated every day and entered in the laboratory books in order to ascertain day by day if the amount of sugar expected after the analysis is really present in the shape of finished or half-finished product.

After a series of experiments made in well equipped Java factories, it became evident that the sugar obtained in regular working could be represented by the formula:—

$$a.s. \text{ on 100 parts of mixed juice} = s.m.j. - 0{\cdot}4\,(b.i. - s.m.j.).$$

In this shape the formula serves for the calculation of the sugar available from 100 parts of mixed juice, but for the calculation of the sugar available from 100 cane, or from a given quantity of sucrose present in a juice of a given quotient it may be simplified like this:—

$$a.s. = \left\{ s.m.j. - 0{\cdot}4\,(b.i. - s.m.j.) \right\} \times \frac{w.s.i.}{s.m.j.}$$

$$a.s. = \frac{w.s.i. \times (s.m.j. - 0{\cdot}4\ b.i. + 0{\cdot}4\ s.m.j.)}{s.m.j.}$$

$$a.s. = 1{\cdot}4\ w.s.i. - 0{\cdot}4\ \frac{w.s.i. \times b.i.}{s.m.j.}$$

$\frac{100 \times s.m.j.}{b.i.}$ = quotient of mixed juice: if we substitute this value in the above equation, we have:—

$$a.s. = 1{\cdot}4\ w.s.i. - 40\,\frac{w.s.i.}{quotient}$$

$$a.s. = w.s.i. \times \left(1{\cdot}4 - \frac{40}{quotient}\right).$$

The weight of available sugar may, therefore, be found by multiplying every day the weight of sucrose indicated in juice with the factor $1{\cdot}4 - \frac{40}{quotient}$ in which quotient is the quotient of purity of the mixed juice during that same day.

6. Available Sugar on 100 Cane.

Multiply the figure for sucrose extracted on 100 cane with the factor $1{\cdot}4 - \frac{40}{quotient}$.

We have already observed that the value "*s.* extr. on 100 cane" is not absolutely sure, in consequence of which the value for the available sugar on 100 cane derived from it is also only approximate. It may not be used as a starting point for the control, but only serves in the daily report to give an idea of the constitution of the cane crushed that day.

7. Normal Juice.

"Normal juice" is the denomination used for the ideal juice, which we fancy we have extracted from the cane by all the mills without reckoning the maceration water, thus representing the mixed juice without the dilution owing to maceration. Formerly we used to consider the first mill juice as the normal juice. This is, however, obviously wrong, since the second and third mills extract a much poorer juice than the first one, even without maceration. In order to correct this it is much better to assume for the composition of the normal juice a juice having the Brix of the first mill juice, and the quotient of purity of the mixed juice. The figures are, therefore, as follows:—

Brix normal juice = *Brix first mill juice.*

$$Sucrose\ normal\ juice = \frac{Brix\ first\ mill\ juice \times Quotient\ mixed\ juice}{100}$$

Quotient normal juice = *Quotient mixed juice.*

When the cane is crushed two or more times without maceration this calculation is of course superfluous, and the composition of the normal juice is identical with that of the mixed juice.

The composition of the normal juice is only required for the calculation of the amount of normal juice extracted per 100 cane; if this figure is not wanted the calculation of the composition of the normal juice may be likewise omitted.

8. Calculated Weight of Crushed Cane ($w.c.$).

The weight of the cane crushed serving for the basis of the control is obtained by direct weighing of the canes carried into the factory, but because the canes in the milling house are not finished every day, and a larger or smaller store remains before the mill, the direct weighing cannot tell us how much cane has been crushed in the foregoing 24 hours. Yet it is necessary to know that, and therefore we calculate the weight of the canes crushed after a somewhat rough method, which may differ from the truth 2% on either side. This difference is insignificant if one only wants to know the figure of cane worked up in a day, but it is too considerable to use it as a basis for the chemical control.

The weight of cane crushed is calculated from the weight of sucrose indicated in juice and the percentage of sucrose extracted on 100 cane after the formula :—

$$w.c. = \frac{w.s.i.}{s.\ extracted\ on\ 100\ cane} \times 100.$$

9. Extraction.

This figure represents the proportion between the sucrose extracted and the sucrose present in the cane, and can be found by dividing 100 × the sucrose extracted on 100 cane by the percentage of sucrose in the cane like this :—

$$Extraction = \frac{s.\ extracted\ on\ 100\ cane \times 100}{s.c.}$$

10. Dilution by Maceration.

Under the denomination "Dilution" we understand the quantity of water added during maceration to 100 parts of normal juice. Its value is calculated from the degrees Brix of both first mill juice and mixed juice, as that calculated from their sucrose contents is not so accurate. Assuming that the total amount of dry substance does not undergo any change by the dilution as the maceration water does not contain dissolved matter we know that the dry substance in the mixed juice comes exclusively from the normal juice. Now we calculate how many parts of mixed juice of a given Brix are required to contain as much dry substance as 100 parts of normal (first mill) juice of a certain Brix.

$$x\ b.i. = 100\ b.$$

$$x = \frac{b.}{b.i.} \times 100$$

Of these $100\,\frac{b.}{b.i.}$ parts of mixed juice, 100 parts are the original normal juice and the balance is the water added by the maceration; in order to find this we subtract 100 and the formula becomes like this :—

$$\text{Dilution by maceration} = 100\,\frac{b.}{b.i.} - 100 \text{ or } = 100\left(\frac{b.}{b.i.} - 1\right)$$

11. Percentage of Normal Juice Extracted on 100 Cane.

Although this figure, owing to considerable fluctuations in the fibre content of the cane, is not apt to yield a good insight in the crushing power of the mills and in this respect remains behind the figures for loss of sucrose in the bagasse on 100 cane or for the extraction, some mill owners still want it recorded and therefore the calculation is given here.

The quantity of sucrose extracted in juice on 100 cane is already calculated and equally the sucrose content of the normal juice is known, so a simple equation yields the percentage of normal juice extracted per 100 cane:—

$s.f.m.j. : 100 = s.\ extraction\ on\ 100\ cane : x$

x or *percentage of normal juice extracted from* 100 *cane* =

$$\frac{s.\ extracted\ on\ 100\ cane}{s.f.m.j.} \times 100.$$

12. Weight of Sucrose Lost in Bagasse and in Filter Press Cakes.

With a view to diminishing the calculating work for the fortnightly or monthly reports, and so simplifying the supervision of this work, it is advisable to calculate day for day, besides the weight of sucrose entered into the factory and that of the available sugar, also the weight of sucrose lost in the bagasse and in the filter-press cakes. The sucrose lost in bagasse on 100 cane is already known (*s.b. on* 100 *cane*) as well as the weight of cane crushed (*w.c.*), so that the formula for the weight of sucrose in bagasse is:—

$$Weight\ of\ sucrose\ lost\ in\ bagasse = \frac{w.c. \times s.b.\ on\ 100\ cane}{100}$$

The sum of $w.c.$ and $w.c. \times \frac{s.b.\ on\ 100\ cane}{100}$ represents the weight of sucrose entered into the mill in the cane, a figure which will afterwards be used in the final sucrose balance.

In the same way the sucrose lost in filter-press cakes is calculated from the weight and the sucrose content of the cakes or mud.

13. Weight of Sucrose in Returned Sugar.

Sometimes sugar or seconds are returned into the juice. In this case these products should be weighed and analysed, and the weight of sucrose returned in the course of manufacture should be calculated and recorded.

14. Centrifugal Outcome.

In most cases molasses are returned into the pan when boiling first sugar which renders the direct estimation of the sugar extracted from 100 parts of original masse-cuite impossible. When we assume that the molasses returned only serve to liquify the mass and do not part with any more sugar themselves, the centrifugal outcome of the first

masse-cuite can be calculated in an indirect but reliable way, starting from the quotients of the syrup, the molasses and the sugar.

Let us consider first all these constituents in an anhydrous state and suppose the amount of dry marketable sugar from 100 parts of dry masse-cuite to be x, then the quantity of molasses $= 100 - x$, and we form the following equation :—

$x \times$ *quotient of sugar* $+ (100 - x) \times$ *quotient of molasses* $= 100$ *quotient masse-cuite.*

$x \times$ (*quotient sugar* $-$ *quotient molasses*) $= 100 \times$ (*quotient masse-cuite* $-$ *quotient molasses*).

$$x = \frac{100 \times \textit{quotient masse-cuite} - \textit{quotient molasses}}{\textit{quotient sugar} - \textit{quotient molasses}}$$

This formula is only calculated for the anhydrous constituents; if we want it for the constituents with their proper amount of moisture the equation is as follows :—

Centrifugal outcome $=$

$$100 \times \frac{\textit{quotient masse-cuite} - \textit{quotient molasses}}{\textit{quotient sugar} - \textit{quotient molasses}} \times \frac{\textit{Brix masse-cuite}}{\textit{Brix sugar}}$$

When we substitute the value for quotient of masse-cuite by that for the value of the quotient of syrup or clarified juice we can also calculate how much sugar was obtained from 100 parts of any given quantity of syrup or juice of a certain constitution, provided no technical losses have taken place by spilling or leaking.

Recapitulation of the Daily Calculations.

Sucrose on 100 cane. $s.c. = s.f.m.j. \times \textit{factor}.$

Sucrose lost in bagasse on 100 cane. $s.b.$ *on* 100 *cane* $= s.b. \frac{f.c.}{f.b.}$

Sucrose in juice on 100 cane. $s.$ *extraction on* 100 *cane* $= s.c. - s.b.$ *on* 100 *cane.*

Weight of sucrose entered in juice. $w.j. \times \frac{s.m.j.}{100}$

Weight of available sugar. $a.s. = w.s.i. \times \left(1{\cdot}4 - \frac{40}{\textit{quotient}}\right)$

Available sugar on 100 cane. $a.s.$ *on* 100 *cane* $= s.$ *extr. on* 100 *cane* $\times \left(1{\cdot}4 - \frac{40}{\textit{quotient}}\right)$.

Sucrose in normal juice. $s.n.j. = \frac{b. \times \textit{quotient mixed juice}}{100}$

Weight of cane. $w.c. = \frac{w.s.i.}{s.\ \textit{extr. on } 100\ \textit{cane}} \times 100$

$\textit{Extraction} = \frac{s.\ \textit{extr. on } 100\ \textit{cane}}{s.c.} \times 100$

Dilution by maceration. $100 \left(\frac{b.}{b.i.} - 1\right)$

Percentage of normal juice extracted on 100 cane.

$$\frac{s.\ extr.\ on\ 100\ cane}{s.f.m.j.} \times 100$$

Weight of sucrose lost in bagasse $= w.c. \times \frac{s.b.\ on\ 100\ cane}{100}$

Weight of sucrose lost in filter press cakes $= weight\ of\ cakes \times$
$$\frac{sucrose\ in\ 100\ cakes}{100}$$

Weight of sucrose in returned seconds $= weight\ of\ returned\ sugar \times$
$$\frac{sucrose\ in\ 100\ returned\ sugar}{100}$$

$$\text{Centrifugal outcome} = 100 \times \frac{quotient\ masse\text{-}cuite - quotient\ molasses}{quotient\ sugar - quotient\ molasses} \times \frac{Brix\ masse\text{-}cuite}{Brix\ sugar}$$

(To be continued.)

SUGAR REFINING WITHOUT CHARCOAL.

By Sigmund Stein.

(Sugar Expert, Liverpool.)

I have received during the last few weeks various inquiries regarding different plants for refineries in East India. It is a known fact that the natives of India will not touch sugar in the manufacture of which animal charcoal is used. It is quite possible to manufacture perfectly white, bright crystals and cubes without such charcoal, and turn out products which will compete very well with the imported Austrian, German, and British goods.

The process of refining is very simple indeed. Without any great outlay of capital, small refineries could be started in East India to refine the native "Jaggery" sugar. Any native sugar polarizing 74 to 86 is suitable for this process. There is no reason why India, with her enormous sugar production, should not start dozens of small refineries, and partly cover the demand for sugar in the country. It would be a very paying business, and these small refineries could soon be enlarged when the importation of refined sugar would cease, and India would be able to refine all her own sugar.

I give here a simple outline of a process of mine for refining cane sugar without charcoal, which may be used advantageously in East India:—

1. The native sugar is dissolved in a melting pan, which is provided with a double bottom and a proper stirring arrangement.

2. The dissolved liquor is filtered through filter presses or filter bags.

3. The clear juice from the filters is boiled in a vacuum pan.

4. The masse-cuite from the vacuum pan is let off into a large mixer able to hold the whole contents of the vacuum pan. The boiling in the vacuum pan must be done very carefully and skilfully. The mixer must have a stirring arrangement, and be so arranged that proper crystals would be formed in a short time.

5. After 10 hours the masse-cuite is perfectly ready, and could be centrifugalled off.

6. The sugar so resulting is used for dissolving purposes, and is treated as described further on. The syrup from the centrifugal machine is drawn into the vacuum pan again with the raw sugar liquor.

7. The sugar obtained from this first centrifugal process is dissolved in another melting pan, and treated there with phosphoric acid or phosphate of lime, sulphurous acid and alumina compounds and tannin. After treatment of the juice with the chemicals described, the sugar liquor will be decolorized.

8. The liquor so chemically treated is filtered through filter presses.

9. The liquor from the filter presses is boiled in a vacuum.

10. The masse-cuite is machined in a centrifugal machine, and washed in this machine with hot water or steam.

11. The sugar turned out will be perfectly bright and sparkling, and in any point perfectly able to compete with the imported European sugars. Crystals so received can be packed at once in bags or barrels.

12. If cubes are required, these crystals could be formed into pressed cubes, or if English cubes are required, the masse-cuite is let off into specially adapted centrifugals, which form sticks direct. These sticks are chipped afterwards into cubes or cubelets

13. By this process it is possible to make from the masse-cuite in one day cubes ready for packing.

I should be very glad to give interested parties more detailed information.

THE BOURBON CANE.

In his Annual Report of the Botanic Department, Trinidad, for the year ending March, 1904, Mr. J. H. Hart, F.L.S., writes as follows on the seedling canes and the identity of the Bourbon species:—

"The experiments with seedling canes have been continued with satisfactory results. From the seedlings raised at St. Clair there is now a selection of canes which class themselves with some of the best raised in other colonies. Through the kindness of Professors Harrison and Watts, I have been able to procure type specimens of a few varieties grown in Demerara and Antigua. Grown in Barbados, the Trinidad canes have proved true to the value shown by the local examination, and in some cases they have shown to even better advantage. It was suggested by a leading planter that trials should be made of canes planted in alternate rows, and in accordance therewith the Aranguez 'Bourbon' and the 'Caledonian Queen' were planted side by side in long rows. It was soon discovered that the 'Caledonian Queen' was much the stronger of the two varieties, and the result of the yield, with the analysis, made this still more apparent. 'Caledonian Queen' yielded at the rate of 35 tons to the acre while the 'Bourbon' only gave 3·8 tons, the percentage of sucrose of the former being 18·9 and of the latter 15·45. Another 'Bourbon,' which is of a different character, yielded at the rate of 25·87 tons to the acre, but it was planted adjacent to weaker varieties, which in some measure accounts for its better yield. The yield in sucrose of this variety of 'Bourbon' was 17·14. The difference in the sucrose yield of the two 'Bourbons' is to be clearly accounted for by their individual characteristics, taken together with the conditions of environment. Close observation led us to doubt the identity of the two 'Bourbons,' and the matter was discussed in the Departmental Bulletin for January, 1904, under the heading of 'What is the Bourbon cane?' and I give the following extract, as a record of observations made during the year.

"During the experiments in raising seedling canes at St. Clair we took for a standard a sample of 'Bourbon' plants which were selected and presented to the department by the late Mr. J. S. Wilson, of *Aranguez* estate. For several years the analysis of this cane showed results below that of the regular yield of Bourbon canes on estates in other parts of the Island, and it was therefore considered questionable whether there was complete identity between the Bourbon as grown on different estates or not.

"With a view of testing this point I secured plants of the 'Bourbon' grown on one of the Colonial Company's estates through the kindness of P. Abel, Esq., the Attorney of the Company.

"The difference between the appearance of the two canes, and the results of their analysis is equally striking. In the former the colour

of the cane is essentially distinct, the Colonial Company's cane being a much brighter and cleaner yellow than the Aranguez. The habit, weight per acre, and yield of sugar are also strongly in contrast.

"The analytical results are briefly as follows:—

"BOURBON."	Season, May, 1903.					
	Per cent. Sucrose.	Per cent. Glucose.	Lbs. per gallon Sucrose.	Lbs. per gallon Glucose.	Estimat'd Sugar, tons per acre.	Specific Gravity.
Colonial Coy's. Cane..	17·14	1·25	1·849	·125	3·15	1078
Aranguez..	15·45	1·40	1·656	·140	·38	1072
Caledonian Queen ..	18·09	0·50	1·953	·050	4·11	1079

"In previous years the result of the Aranguez yield was similar, but the estimated yield of sugar for 1903 must not be taken to be an accurate one for this variety, as it happens to be based upon the returns of an experimental plot, planted in a particular manner, which allowed one cane to take advantage of another. Caledonian Queen and Bourbon were planted in alternate rows, a suggestion of an experienced planter; the result being that the former overgrew the latter. The result is seen in the fact that while the Caledonian is over average, as to weight per acre, the Bourbon is much under average. The Caledonian Queen practically overgrew and robbed the Bourbon of its nutriment to such a degree that I estimate the area on which the calculations should have been based should have been increased by one-fortieth, and the area upon which the Bourbon was grown decreased by the same amount. Although on the field one-twentieth of an acre of each cane was planted, yet practically the ground occupied by each was Caledonian Queen three-fortieths, Bourbon one-fortieth, an adjustment which will make a considerable difference in the estimate of value of the canes as shown by the analytical returns. The Caledonian Queen gave a yield, side by side with the Bourbon, as seen in table.

"Now, our experiments appear to show that we have secured in what are known as 'Bourbon canes' two distinct varieties. If this is so, a further question may well be asked. Are these canes merely varieties of the one kind, or have they an independent origin?

"Personally I am of opinion that there is not only one but dozens of different kinds of the so-called 'Bourbon' canes; which hypothesis would well explain the variable results obtained by different estates.

"As a matter of fact, almost any yellow cane, unless it has some

specially marked distinctive feature, is called a 'Bourbon' on the estates; and on our experiment plots I have frequently heard seedlings called 'Bourbon' which I know to have originated from varieties quite distinct from the Bourbon, and therefore not of the same family or blood relationship at all.

"Such a mixture of varieties as this, if it exists (?), and I have the opinion of one of the best planters with whom I have discussed the matter that it does, cannot be good for the industry. This gentleman says: 'The extremes of readings for the two Bourbons may be taken to prove what I have always said—that variations in that cane are as great as any observed between it and any other varieties.' Now, as the Bourbon has been always taken as a standard in cane experiments, the question arises what 'Bourbon' has been used? Is it the same or different to that used in other colonies? If not, the results of two places working with a different standard would not be easily compared. The question, however, appears to offer a means for simple solution. Let specimens of the so-called 'Bourbon' on each estate be sent to a central station, and grown in plots side by side. The best kind of 'Bourbon' could then easily be selected, and a standard fixed upon which should be common to all experiment stations to their considerable benefit. Again, it may be possible, and I consider probable, that there may be 'Bourbons' which are disease-resisting canes, as well as Bourbons that easily succumb to Fungi; and this might easily be proved at the same time.

"Further, there may be 'Bourbons' that produce fertile seed, as well as some that are infertile, a possibility which would explain the power to raise seedlings in one place and not in another. If one kind could be found of high quality, which could readily be reproduced from seed, it appears clear that the chances of getting improved canes would be greater, coming from the long acknowledged best of the cane tribe than from canes whose claim to public favour is not in any way so prominently put forward."

DEXTROSE AND LEVULOSE CALCULATIONS.

M. Remy in the *Bulletin* (V. XXI., p. 1002) attempted to show that in estimating dextrose, levulose, and sucrose in a mixture, the rotatory power of levulose should be observed in an aqueous instead of in a hydrochloric acid solution, as indicated by the writer in a previous paper.

M. Remy, in order to prove his case, modified the formula of Clerget, and instead of finding 33·46% of sucrose in the molasses analysed by M. Zamaron, and which served us as a test sample, only found 32·50.

Invert sugar being composed of equal parts of dextrose and levulose, by observing the rotatory powers of levulose, in an aqueous

as well as in an acid solution, we can calculate the quantities of the two sugars present, and thus prove which method gives a result in accordance with the truth.

We know that 16·29 gr. of pure sugar give 17·15 gr. of invert sugar having at 0° a left-handed deviation of 44 saccharimetric degrees, when employing Clerget's method of inversion.

The value $\frac{a\,l}{V}$ at 0° of levulose in aqueous solution is—

In saccharimetric degrees	.. .. ..	− 9·3584
In HCl solution its value is	.. ....	− 10·0193

The value $\frac{a\,l}{V}$ of dextrose is + 4·8887.

If we introduce these values into Biot's formula we have:—

1st case: Levulose in aqueous solution—

$$\text{Dextrose} = \frac{(9{\cdot}3584 \times 17{\cdot}15) - 44{\cdot}0}{9{\cdot}3584 + 4{\cdot}8887} = 8{\cdot}176$$

$$\text{Levulose} = \frac{(4{\cdot}8887 \times 17{\cdot}15) + 44{\cdot}0}{9{\cdot}3584 + 4{\cdot}8887} = 8{\cdot}974$$

2nd case: Levulose in hydrochloric solution—

$$\text{Dextrose} = \frac{(10{\cdot}0193 \times 17{\cdot}15) - 44{\cdot}0}{10{\cdot}0193 + 4{\cdot}8887} = 8{\cdot}575$$

$$\text{Levulose} = \frac{(4{\cdot}0887 \times 17{\cdot}15) + 44{\cdot}0}{10{\cdot}0193 + 4{\cdot}8887} = 8{\cdot}575$$

We thus find in the first case that when using the rotating power of levulose in an aqueous solution there is an excess of levulose, whereas in the case of an acid solution we obtain the normal proportions of invert sugar, *i.e.*, equal parts of dextrose and levulose.

From these data it follows that in analysing a mixture of dextrose, levulose, and sucrose by the Clerget method of inversion, the rotatory power of levulose should be observed in an acid solution for the determination of the reducing sugars.

If instead of employing Clerget's formula—

$$\frac{(P \pm P') \times 100}{144 - \frac{1}{2}t}$$

we follow the method given by Landolt and Herzfeld, and use the following formula:—

$$\frac{(P \pm P') \times 100}{142{\cdot}6 - \frac{1}{2}t}$$

the rotating power of levulose will be altered and will become 106°77.

In short:—

Rotation of dextrose 8·575 × 4·8887	..	+ 41·92
Rotation of invert sugar	.. ..	− 42·60
Rotation of levulose	.. ..	− 84·52

The rotating power of levulose at 0° will be:—

$$\frac{84{\cdot}52 \times 100}{8{\cdot}575 \times 9{\cdot}231} = -\ 106°77$$

and this is the figure which should be employed to establish the value $\frac{a\,l}{V}$, when the inversion is calculated according to the German formula.

It is therefore necessary, as we have already stated, to follow strictly the figures given for inversion, as otherwise inaccurate results will accrue.—(M. M. Buisson in the *Bulletin des Chimistes.*)

PRELIMINARY REPORT OF SUGAR BEET GROWING EXPERIMENTS IN GREAT BRITAIN AND IRELAND, 1904.

By Sigmund Stein.

(Sugar Expert, Liverpool.)

The sugar beets which have been grown this year in England, Scotland, and Ireland, are as far as can be ascertained at the present very satisfactory indeed. We have suffered in this country from the drought, the same as on the Continent. The British sugar beets have less weight this year but are very much richer in sugar content and quotient of purity. During the last week or two we have had some rain in different parts of the country, and this may have done some good to the sugar beet crop. The beet cultivators are anxiously watching the movements of the barometer as everything now depends upon the proper moisture which the sugar beet root requires. If rain comes now abundantly, it is not too late for the British roots to strike well.

I can recollect myself on the Continent summers with very great drought during the months of July and beginning of August, and then rain falling in the middle of August; nothing was spoiled, and a good beet crop resulted. Everybody who knows the sugar beet will know how hardy and enduring it is.

In the samples which have been sent to me for analysis, I notice that those beets which have been grown earlier in the year, say March or the beginning of April, are larger in size and more mature than those which have been grown in May.

The average of 19 experiments of the analyses of British sugar beet roots shows the following result:—

Analyses of roots made on the 15th August, 1904:—

Number of roots analysed	190	
Average weight of roots with leaves	1266	grammes
,, ,, without leaves	417	,,
Largest root with leaves	1619	,,
,, without leaves	617	,,
Smallest root with leaves	395	,,
,, without leaves	201	,,

Specific gravity	1·0904
Degree Brix (dry matter)	21·60
Sugar in 100 parts of the juice	18·70
Quantity of non-sugar	2·90
Quotient of purity	86·58
Quantity of sugar in 100 parts of root	15·90

A peculiarity is noticeable this year in that the sugar beetroots are much dryer than in my previous experiments, containing only 90·50% of juice and 9·5 of fibre.

The interest taken in these beet growing experiments in England, Scotland, and Ireland is greater than ever, and many people are watching carefully this year's results.

I will not issue a further preliminary report of the year 1904, but my definite (10th) report of my sugar beet growing experiments will be issued as usual in December.

CONSULAR REPORTS.

France.

Cochin China.—By ordinance of September 5th, 1903, the Governor-General has promulgated in the colony the Presidential decree of August 21st, 1903, relating to import duty on sugar, viz.:—Sugar fulfilling the conditions called for by the Brussels Convention of March 5th, 1902, and coming from countries parties to the said convention:—Refined and assimilated, per 100 kilos. net, 6 fr.; others, on 100 kilos. net of refined sugar, 5 fr.

All other sugars not referred to in the Brussels Convention:—Prohibited.

Black sugar, called "Galette Chinoise":—Per 100 kilos. of effective weight, 8 fr.

Greece.

Piræus and District.—The quantities and values of sugar imported into Piræus District during 1903 and 1902 were as follows:—

1903. Quantity. Tons.	1903. Value. £	1902. Quantity. Tons.	1902. Value. £
3,989	35,900	4,112	35,666

Practically all the sugar came from Austria-Hungary.

Italy.

The manufacture of beet sugar has progressed by leaps and bounds. Its production is now about sufficient to supply the requirements of the home market. 1,000,000 tons of raw sugar were produced in Italy in the year 1902, and before long it is probable that there will be a surplus for export.

Russia.

The British Consul, in his report for the year 1903, says:—

It would perhaps be difficult to find anywhere in the world an industry more subject to State control than the production of sugar in Russia. The law of November 20th, 1895, had for one of its declared objects the limitation of production to the satisfaction of home necessities, but it has not achieved this result; nor have the laws of April 11th, 1900, and May 12th, 1903, been more successful in checking over-production; the latest of these laws facilitates the export of sugar in a denaturated state for cattle feeding and industrial purposes.

In 1903 there were 275 sugar factories at work, and in spite of all legislative safeguards they exceeded their "normal" production by considerably more than 10 per cent.

The average cost of production, which was nearly 2d. per lb. in 1895, had fallen to $1\frac{1}{2}$d. in 1902, and certain factories now produce at $1\frac{1}{4}$d.; roughly speaking, the excise duty is equal to the cost of production.

The area under beetroot in Russia (1903) amounted to 1,390,000 acres, exceeded that in Germany by 35 per cent., and is the largest in the world, but Germany's production was nearly one-and-a-half times as great.

During the writing of this report statistics have been issued (May 28th, 1904) showing that the area under beetroot in 1904 is 1,150,000 acres, 200,000 acres less than in 1903, and 300,000 acres less than in 1902.

The annual consumption per head in Russia is under 18 lbs., about one-fifth of the consumption per head in the United Kingdom.

The export of Russian sugar in 1903 amounted to about 240,000 tons, double the quantity exported in 1902; amongst the chief countries to which it was sent were Persia, Turkey, China, Afghanistan.

A well-equipped sugar factory, worked by hydraulic power on the turbine system, has been built at Kaufmannskaya station, 30 versts from Tashkent, and is the first establishment of the kind in Turkestan; it is to begin working in the autumn of 1904, when the first crop of beetroot is harvested; it cost £60,000, and is to produce 5,000 tons of sugar annually. Over 3,000 acres of beetroot are being planted, and in 1905 the area is to be increased to 10,000 acres of irrigated land. The white beet yields 24 cwt. of sugar per acre; the red beet less.

Spain.

Saragossa.—The principal industry here is the extraction of beet sugar. The total production of the eight factories in this district during the year 1903 amounted to 50,000 tons, all of which was for home consumption.

Turkey.

Baghdad.—Large quantities of loaf sugar were imported from Marseilles, Belgium, and Egypt during 1903, and realised fair profits. The greater part of this sugar was re-exported to Persia. There were many complaints about the inadequate means of conveyance from Basrah to Baghdad, and about the high freights. Formerly the greater part of this sugar was carried by native sailing craft, but this has been stopped lately because the insurance companies refuse to take the risk of such transport.

Erzeroum District.—There has been a considerable increase of late years in the amount of sugar imported, concurrently with a larger consumption of tea (which the natives sweeten excessively) and less coffee. Most of it comes from Marseilles, the trade-mark bearing the British arms. A small quantity comes from Vienna in loaves like the French ones, packed in the same way, with a similar trade-mark bearing an imitation of the Austro-Hungarian arms.

China.

Chinkinang.—The trade in sugar, foreign and native, has been as follows:—

	Quantity. 1903.	1902.	Average previous Five Years.
	Cwt.	Cwt.	Cwt.
Sugar, foreign	643,821	897,478	436,209
,, native	186,862	222,918	311,867

The total value in 1903 was £420,000. An increasing tendency is shown for native sugar to become foreign, that is, as explained in previous reports, for Swatow sugar to pass through Hong-Kong and thus become foreign merchandise in a customs sense.

French Indo-China.

The production of sugar is small, being estimated at only some 50,000 tons for the whole country, but the climate and soil in several provinces, especially in Annam, are supposed to be suitable, and several planters have lately started plantations.

Attempts have recently been made to introduce foreign mills for crushing the cane, but so far with little success, some of the farmers recognising their advantages, whilst others think the native article equally good, regard being had to the price and cost of working.

Canary Islands.

The large increase in the quantity of sugar imported during 1903 was due to the decreased cultivation of sugar cane in these islands. Farmers are now planting bananas instead of sugar cane, the profits on bananas being so much greater and the prospects brighter. It is true that a fair quantity was shipped from the United Kingdom, but the shipments consisted almost exclusively of Continental beet sugar.

The duty on sugar is heavy, viz., 70 pesetas per 100 kilos. Cane sugar would be too expensive to import and sell after paying duty.

Imports during 1902 and 1903:—

	1902. Tons.	1903. Tons.
United Kingdom	3	120
Germany	24	364

ARGENTINA.

Rosario.—Exports of sugar:—

	1902 (Poor Harvest). Tons.	1902 (Poor Harvest). $	1903 (Good Harvest). Tons.	1903 (Good Harvest). $
Unrefined sugar	37,378	2,707,253	28,880	2,493,312

PUBLICATIONS RECEIVED.

"DIE DAMPFWIRTSCHAFT IN DER ZUCKERFABRIK." (The employment of Steam in the Sugar Factory.) By Karl Abraham, C.E. 120 pp. Price, Mk. 4. Schallehn & Wollbrück, Magdeburg.

Abraham's long connection with the sugar industry as factory manager and consulting engineer should fit him for the task of compiling a treatise on the use of steam in sugar factories. His work, contrary to what we usually expect from Germany, is not voluminous to a wearisome degree, but is short and terse; and the reader who possesses a moderate acquaintance with German would not find the book above his powers. The author deals first with the employment of steam in the several stages of the sugar manufacture, diffusion, saturation of syrups, boiling, &c.

A second part deals with the General Distribution of Steam in the Factory, Methods of Economisation, Questions of Temperature and their Influence on the Work, Heating Surfaces, &c. The addition of a "contents" page and Index would improve the book considerably.

"CANE SUGAR MACHINERY." By O. B. Stillmann, 92, William Street, New York. 4to., 144 pp. $5·00.

This book in parallel English and Spanish is openly admitted by the author to have been written with a view to pushing his business as a sugar plant contractor. Profuse illustrations of American and British machinery are given, also of factory construction and appliances, and advice is tendered as to the best designs. As the author does not appear to be interested in any particular firm, his views should be fairly free from bias; but we wonder how many individuals will care to pay $5·00 for what is after all only a glorified machinery catalogue.

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. THOMPSON, C.E., F.C.S., M.I.M.E., Chartered Patent Agent, 6, Lord Street, Liverpool; and 322, High Holborn, London.

ENGLISH.—APPLICATIONS.

15934. C. STIEPEL, London. *Improved manufacture of betaine and its salts from the molasses and waste products of beetroot sugar manufacture.* 18th July, 1904.

16262. A. BÖRNER, London. *A new or improved process for the manufacture of starch and sugar.* (Complete specification.) 22nd July, 1904.

16546. S. STEIN and M. LOEWENTHAL, Liverpool. *An improved manufacture of sugar.* 27th July, 1904.

ABRIDGMENT.

7947. J. KOSTALEK, Prague, Austria. *Parallel filter.* 6th April 1904. This invention relates to parallel filters employing a granular filtering medium, the arrangement of removable juice inlet or outlet pockets or tubes made of flat or corrugated perforated sheet-metal or of wire gauze, the said pockets being suspended alternately and parallel to each other and connected to the inlet and outlet tubes respectively, the said pockets being separated from each other by means of a granular filtering medium for the purpose of enlarging the filtering capacity of the filter.

GERMAN.—ABRIDGMENTS.

14857. WILHELM KOLLMANN, Barmen. *A beetroot shredding machine with means for holding up the roots to which a rotary movement is imparted opposite to that of the knife disc.* 23rd January, 1902. Means for holding the beet roots are arranged over a rotary knife disc, and serve for holding the roots in place when being sliced. The knife holders are spirally arranged on a rotary cone. The cone and the knife disc rotate in opposite directions.

149523. CARL STEFFEN, Vienna. *A pressing process for obtaining pure concentrated beetroot juice and saccharine residuals poor in water.* February 13th, 1901. Fresh beetroot shreddings or slices and the like are heated to temperatures of from 60 to 100° (preferably from 80 to 85°) by means of crude beet juice or juice from the press heated to 60°, or up to its boiling point, and after the entire or partial separation of the crude juice employed for heating or even in conjunction therewith, the juice is obtained by pressing out in ordinary pressing apparatus. The pressed crude juice is again heated whereupon it can act upon fresh quantities of disintegrated beet in a similar manner, and for the same objects before it is subjected to the usual treatment

for making sugar. A disintegration of the hot beetroot shreddings freed more or less from the warm juice, may be undertaken before the expressing and then the disintegrated beetroot may be divided as mentioned above into pressed juice and pressed residuals. A certain quantity of the disintegrated roots may also be mixed with such large quantities of the pressed beetroot juice or crude beetroot sap brought to 60° or to boiling point (preferably from 97° to boiling point) with the object of rapidly heating to the desired temperature, so that the total heat existing in the mixture of crude juice and beetroot shreddings suffices to produce the degree of temperature (preferably 80 to 85°) sought after for the beetroot shreddings, as a uniform temperature in the total material mixed. The process hereinbefore described may also be employed on cold made beetroot mash.

150629. Dr. HEINRICH WINTER, Charlottenburg. *A stirring apparatus more particularly for mash tubs.* (Patent of addition to Patent No. 140893 of August 21st, 1902.) October 2nd, 1903. On the inner face of the agitation vat rows of check pins are arranged in such a way that the bars of the stirrer in their rotation strike against them in order to loosen the pasty masses from the bars and to cause them to slip off the same.

150933. JAMES WRIGHT MACFARLANE, Kingston, Glasgow. *A centrifugal with means for separating the drain.* February 20th, 1903. The separation of the drain into two different channels takes place by means of a vertical partition which is mounted by means of oblique contact surfaces on rollers and when suitably rotated by means of a toothed rack gear, may be raised or lowered and thus adjusted to the respective drain gutter.

151007. HERMANN SCHULZE, Bernberg. *Diffusion process.* February 13th, 1902. The juice circulates from the diffuser, which is in communication above with the atmosphere, through the respective calorisator and back merely by means of the upward movement induced by the introduction of heat into the calorisator or stand pipe, and if desired simultaneously in two or more diffusers.

151254. JULES RAGOT and HENRI TOURNEUR, Paris. *A mashing apparatus with means for equalising the temperature for masse-cuite.* January 7th, 1903. This invention relates to a stirring mechanism for mashing apparatus for masse-cuite. Two or more coils of pipes running in opposite directions are mounted on a horizontal shaft divided into a suitable number of parts. A suitable heating or cooling medium is sent through the coils of pipes. The connection of the coils of pipes is operated by means of a series of pipes which regulate the course of the heating or cooling medium in succession to the coil and back again to the point of admission.

151591. JAMES WRIGHT MACFARLANE, Kingston, Glasgow. *An apparatus for cleaning sugar centrifugals.* February 20th, 1903. This

invention relates to a device for cleaning the interstice between the sieve separating the mass to be centrifugalled and the cylindrical or tapering casing surrounding said sieve. It consists in the upper edges of the sieve forming the drum of the centrifugal and the casing being arranged at a slight distance apart and provided with horizontal flanges between which a narrow slot leading to the space formed between the sieve and the casing remains open, so that into this narrow slot a cleansing fluid may be introduced by means of a pipe for washing the outer wall of the sieve and the inner wall of the drum casing, and thus rendering it unnecessary to remove the drum from the machine for the purpose of being cleaned.

152591. COUNT BOTHO SCHWERIN, Wildenhoff, East Prussia. *A process for the extraction of sugar by means of electricity.* (Patent of addition to Patent No. 124430 of 27th October, 1900.) 13th February, 1902. The sugar solution which is discharged from the negative pole is allowed to flow through a layer of oxides of the earth metals or alkaline earths or other hydrates, in order thus to obtain a solution free from albumen.

152270. Miss HELENE WOLTMANN, Magdeburg. *A centrifugal in which the separation of the drain is effected by means of a revoluble ring over the syrup dish.* May 2nd, 1903. The separation of the drain is operated by means of a revoluble ring over the syrup dish, the latter being divided into four compartments connected crosswise by their discharge pipes, of which only the outer two compartments may alternately be closed or opened by a suitable turning of the partly closed and partly open ring.

Copies of all published specifications with their drawings in these lists can be obtained from W. P. Thompson & Co., 6, Lord Street, Liverpool, at One Shilling a copy for English or American Patents, and Two Shillings for German. In ordering please give number and date.

IMPORTS AND EXPORTS OF SUGAR (UNITED KINGDOM)

To end of July, 1903 and 1904.

IMPORTS.

Raw Sugars.	Quantities.		Values.	
	1903. Cwts.	1904. Cwts.	1903. £	1904. £
Germany	2,206,302	3,845,836	894,928	1,704,439
Holland	138,078	123,866	51,708	56,437
Belgium	608,416	225,004	253,689	97,393
France	459,506	153,556	202,303	71,854
Austria-Hungary	1,411,283	680,971	594,545	306,550
Java	....	1,034,877	....	428,871
Philippine Islands	70,646	....	25,285	....
Cuba	332,413	....	163,822	....
Peru	196,111	585,473	76,771	264,756
Brazil	65,720	82,210	25,696	31,171
Argentine Republic	178,283	....	80,432	....
Mauritius	222,170	321,538	78,546	117,181
British East Indies	207,536	153,468	74,322	62,136
Br. W. Indies, Guiana, &c.	486,138	777,870	303,442	503,012
Other Countries	311,959	401,622	138,496	185,602
Total Raw Sugars	6,894,561	8,386,291	2,963,985	3,829,402
Refined Sugars.				
Germany	8,449,783	6,872,610	4,389,327	3,859,151
Holland	1,267,844	1,853,545	730,632	1,092,605
Belgium	82,901	246,879	48,258	141,225
France	511,046	1,281,638	293,085	701,798
Other Countries	684,946	167,246	337,107	88,535
Total Refined Sugars	10,996,520	10,421,918	5,798,409	5,883,314
Molasses	876,297	1,046,271	164,968	193,323
Total Imports	18,767,378	19,854,480	8,927,362	9,906,039

EXPORTS.

British Refined Sugars.	Cwts.	Cwts.	£	£
Sweden and Norway	13,365	18,042	6,968	9,123
Denmark	58,144	72,355	31,907	36,420
Holland	36,284	34,128	19,675	17,870
Belgium	4,708	6,527	2,356	3,458
Portugal, Azores, &c.	4,201	9,422	2,263	5,029
Italy	5,672	2,565	2,582	1,208
Other Countries	346,944	192,549	210,863	121,277
	469,318	335,588	276,614	194,385
Foreign & Colonial Sugars.				
Refined and Candy	24,841	16,543	15,204	11,277
Unrefined	35,966	60,100	18,706	33,023
Molasses	1,220	1,559	639	888
Total Exports	531,345	413,790	311,163	239,573

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1904. Tons.		1903. Tons.
Total Receipts, Jan. 1st to Aug. 18th ..	1,227,242	..	1,178,950
Receipts of Refined ,, ,, ,, ..	314	..	1,149
Deliveries ,, ,, ,, ..	1,224,636	..	1,112,907
Consumption (4 Ports, Exports deducted) since 1st January	1,151,107	..	1,040,277
Importers' Stocks (4 Ports) Aug. 17th ..	14,767	..	70,428
Total Stocks, Aug. 24th	129,000	..	250,744
Stocks in Cuba ,, ...	54,000	..	217,988
	1903.		1902.
Total Consumption for twelve months ..	2,549,643	..	2,566,108

CUBA.

STATEMENT OF EXPORTS AND STOCKS OF SUGAR, 1903 AND 1904.

(Tons of 2,240lbs.)	1903. Tons.		1904. Tons.
Exports	661,540	..	966,499
Stocks	293,027	..	115,198
	954,567	..	1,081,697
Local Consumption (seven months)	23,145	..	24,360
	977,712	..	1,106,057
Stock on 1st January (old crop)	42,530	..	94,835
Receipts at Ports up to July 31st	935,182	..	1,011,222

Havana, July 31st, 1904.

J. GUMA.—F. MEJER.

UNITED KINGDOM.

STATEMENT OF IMPORTS, EXPORTS, AND CONSUMPTION FOR SEVEN MONTHS ENDING JULY 31ST.

SUGAR.	Imports. 1902. Tons.		1903. Tons.		1904. Tons.	Exports (Foreign). 1902. Tons.		1903. Tons.		1904. Tons.
Refined	608,588	..	549,826	..	521,096	1,626	..	1,242	..	827
Raw	438,393	..	344,728	..	419,314	2,381	..	1,798	..	3,005
Molasses	37,192	..	43,814	..	52,314	60	..	61	..	78
Total	1,084,173	..	938,368	..	992,724	4,067	..	3,101	..	3,910

	Home Consumption. 1902. Tons.		1903. Tons.		1904. Tons.
Refined	605,491	..	519,623	..	533,434
Refined (in Bond) in the United Kingdom	—	..	—	..	295,942
Raw	411,738	..	325,453	.	75,296
Molasses	37,439	..	38,189	..	48,907
Molasses, manufactured (in Bond) in U.K.	—	..	—	..	35,272
Total	1,054,668	..	883,265	..	988,851
Less Exports of British Refined	18,008	..	23,468	..	16,779
Total Home Consumption of Sugar	1,036,660	..	859,799	..	972,072

STOCKS OF SUGAR IN EUROPE AT UNEVEN DATES, AUG. 1ST TO 24TH, COMPARED WITH PREVIOUS YEARS.

IN THOUSANDS OF TONS, TO THE NEAREST THOUSAND.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	TOTAL 1904.
96	488	515	208	128	1437

	1903.	1902.	1901.	1900.
Totals	1715 ..	1738 ..	852 ..	691

TWELVE MONTHS' CONSUMPTION OF SUGAR IN EUROPE FOR THREE YEARS, ENDING JULY 31ST, IN THOUSANDS OF TONS.

(From Licht's Monthly Circular.)

Great Britain.	Germany	France.	Austria.	Holland, Belgium, &c.	Total 1903-4.	Total 1902-3.	Total. 1901-2.
1759	1057	740	467	558	4582	3788	4181

ESTIMATED CROP OF BEETROOT SUGAR ON THE CONTINENT OF EUROPE FOR THE CURRENT CAMPAIGN, COMPARED WITH THE ACTUAL CROP OF THE THREE PREVIOUS CAMPAIGNS.

(From Licht's Monthly Circular.)

	1903-1904. Tons.	1902-1903. Tons.	1901-1902. Tons.	1900-1901. Tons.
Germany	1,950,000 ..	1,762,461 ..	2,304,923 ..	1,984,187
Austria	1,170,000 ..	1,057,692 ..	1,301,549 ..	1,094,043
France	800,000 ..	833,210 ..	1,123,533 ..	1,113,893
Russia	1,200,000 ..	1,256,311 ..	1,098,983 ..	918,838
Belgium	210,000 ..	215,000 ..	334,960 ..	333,119
Holland	125,000 ..	102,411 ..	203,172 ..	178,081
Other Countries.	410,000 ..	325,082 ..	393,236 ..	367,919
	5,865,000	5,552,167	6,760,356	5,990,080

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☞ The Editor is not responsible for statements or opinions contained in articles which are signed, or the source of which is named.

NOTES AND COMMENTS.

Blyth Bros., Mauritius, report shipments of sugar from August 1st to July 31st, 1904, as 218,532 tons, as compared with 150,349 tons for the preceding year.

Exports from British Guiana from 1st January to 6th September:—Sugar, 44,662 tons; rum, 1,270,155 galls.; molasses, 1,111 casks; molascuit, 2,717 tons; cocoa, 100,676 lbs.; as compared with 66,487 tons; 1,642,378 gallons; 3,494 casks; 480 tons; and 102,228 lbs., respectively, for the like period last year.

Progress in British Guiana.

Signs are not wanting that the planters of British Guiana are endeavouring to keep in the van of progress. There is more willingness now to accept technical help from chemists and others, instead of putting obstacles into their way. Centralization is the order of the day and larger and better equipped factories are springing up. Cotton, from which so much was expected, is proving a complete failure. South Sea Island cotton has been tried and found unsuitable; it has, moreover, been attacked by the cotton bug and possibly other diseases. Hence it is evident that the position of sugar as the staple industry is not yet even threatened.

Java Affairs.

The Java crop is estimated at one million tons, seconds included. A much larger proportion of this will come to Europe than has hitherto been the case. As a proof of this we may point out that a short while ago the first cargo of Java sugar since 1884 arrived in Holland for a refinery there. This, it is needless to say, is the outcome of the Brussels Convention. Two and a half million piculs of 1905 crop are already sold at a good price.

Consumption of Sugar in the U.K. and elsewhere.

We note that certain Radical organs of the Press have been reviewing the twelve months following the putting into force of the Brussels Convention, and have satisfied themselves that the latter is proving a burden, and no blessing, to the nation. It is shown that the consumption for twelve months ending August 30th, 1904, is considerably less than in the previous year. But why is it not also shown that the consumption for the first eight months of 1904 exceeds that of the corresponding period of 1903 by over 82,000 tons? This puts a somewhat different complexion on the matter and suggests that it is only time that is required in order to ensure a full recovery from the depression and disorder into which the *bounties*, and not the Brussels Convention, have landed us. When the figures for 1904 are forthcoming, they will form a better basis for drawing conclusions from; but it would be better still to wait another year or two ere attempting to condemn this much-abused Convention. Unfortunately it is too much to expect these Radical scribes to remain silent in the interval. Hence we have to supply a periodical refutation of their fallacious communications. In this number will be found an article on the Cobden Club's latest sayings and doings; there seems to be little brotherly love to lose between the Club Committee and its foreign members, considering the animosity which the former show to any convention which, *inter alia*, increases some benefit to foreign populations. We wonder some of these foreign members, M. Yves Guyot to wit, do not vigorously protest against this apparent slur on their interests. This latter gentleman, it is well known, has worked long and strenuously to obtain for his country, and others, a more natural and plentiful supply of sugar, and having succeeded, he now finds the club of which he is a distinguished member loudly objecting to England's share in that desirable consummation. These objections would be in better part if it could be logically shown that as the consumption increases on the Continent, so ours is bound to decrease; but we know that while there has been a shortage just lately, it will not last long, and that a more plentiful and better distributed supply will very soon be available.

THE BRUSSELS CONVENTION.

Many questions still remain to be settled with regard to the total abolition of bounties as provided for in Article I. of the Convention. Of these the most important is the failure of France to establish refining on bond. This has been fully dealt with in our columns in the Journals for February and September. The latter article has been reviewed in a leading article in the *Journal des Fabricants de Sucre* of the 14th September, and it is satisfactory to note that the arguments and facts put forward by us are not disputed. On the contrary, the Editor concludes as follows: "These observations denote on the part of our neighbours a very manifest feeling of defiance and one which undoubtedly it will not be easy to dissipate." The Paris organ then quotes views similar to our own from the *Deutsche Zuckerindustrie*, which, it says "clearly decides that there exists an indirect bounty to the profit of the French refiner." The Paris journal concludes by saying that, "to judge by these appreciations, it is certain that the new fiscal *régime* of the French refinery will be the object of an attentive examination on the part of the Permanent Commission at Brussels."

A certain impetus may be given to this examination from the fact that paragraphs have recently appeared in the Paris press declaring that at the annual stock-taking on the 1st of September serious errors were discovered in the declarations of a refiner as to the quantity of sugar in store. No such error could occur if the simple system of refining in bond were substituted for the present unsatisfactory and insufficient method of what is *erroneously* called supervision.

A subject of equal importance and more complexity requires immediate consideration. Confectionery, preserves, condensed milk, biscuits, chocolate, "and all other analogous products containing a notable proportion of sugar," are declared by Article I. to be "assimilated to sugar," and therefore no bounty is allowed to be obtained on them. This includes the bounty defined under letter *f* as "the advantages arising from any surtax of a rate superior to that fixed by Article III."—that is, any surtax above six francs per 100 kilogrammes. But, as the result of a former discussion, the Commission have decided that the limit of six francs does not apply to these sugared products, and they now have to determine what the surtax shall be which will prevent sugared products from obtaining the "advantages" defined in Article I.

This becomes more important now that Belgium has permitted sugared products to be manufactured with sugar free from excise duty. It is clear that in this case Belgian sugared products will enjoy advantages arising from a very excessive surtax unless the import duty be reduced to the extent of the excise duty remitted.

A fallacious notion has arisen, that if foreign sugar is also admitted free from excise duty no objection can be raised. This is a confusion of ideas. The admission of foreign sugar free from that portion of the import duty equivalent to the excise duty still leaves it liable to the surtax of six francs, which is more than sufficient to protect the home producer in Belgium against any fear of foreign competition. The confusion has arisen from an erroneous theory having been propounded that remission of the duty on sugar used for sugared products would be a bounty to the sugar producer in Belgium by enabling him to obtain an artificial price for his sugar. This could not possibly be the case, because all sugar in Belgium is sold at the world's price, and therefore the sugar producer would never be able to obtain a fancy price for his sugar from the Belgian confectioner because he would not know to whom the sugar would eventually be delivered. This should have been the conclusive reply to those who advanced the theory; but the reply really made was that foreign sugar could also be used free from duty, which was really no reply, because foreign sugar is always shut out by the six-francs surtax. This theory, however, has no bearing on the fact that if sugar is free from duty when used by a confectioner he is at once protected by a surtax amounting to the whole of the excise duty plus the existing surtax, and will be able to obtain an enhanced price for his sugared products to that amount. This would at once give him the bounty defined under letter *f* of Article I. on a very large scale.

Golden syrup is not a sugared product, nor is it a bye product, because it is made almost direct from raw sugar and contains about 80 per cent. of sugar. It is, in fact, liquid sugar, and should therefore come under the denomination of sugar and be subject to the provisions of Article III., which says that the surtax on its importation must be limited to six francs. A portion of it is invert sugar, but it is now admitted by the recent action of the French Government in regard to invert sugar in sugared products, that invert sugar in such cases must be regarded as sugar.

Next in order of importance comes the suject of the *détaxes de distance*, which, unfortunately, were specially permitted in the case of France. Here again we come to the evils arising from the French system of a debit of duty on the raw sugar entering the refinery. The duty is either paid on the raw sugar or a debit is entered against it which must be discharged within a certain time, either by payment or by the presentation of a certificate of the exportation of an equivalent quantity of refined sugar. This is called the system of "temporary admission," and gives rise to many little permutations and combinations of a profitable character. For instance, the sugar which enjoys the benefit af the *détaxe de distance* of two francs when conveyed from the North of France to a port on the Atlantic or Mediterranean for the purpose of being refined *for exportation*, can,

by a little juggle, obtain the two francs without being subsequently exported. The southern buyer obtains a certificate of export in the Paris market and pays his duty with it, after which he is supposed to have exported the product of the raw sugar and receives his two francs. In order to obtain the certificate he pays to the Paris refiner a premium of, say, one franc on the certificate. That premium is, in fact, an export bounty to the Paris refiner to that amount. The other franc is gained by the southern buyer. He sells the sugar for home consumption, and has gained a franc towards paying the carriage.

Another little abuse is the legal tare, which in some cases is considerably below the actual tare and is said to be a profit to the refiner who imports that kind of package of about one franc or a little more.

Some complaints have been made about excessive reductions in railway rates and shipping freights. These complaints are valid if the reductions are made on State railways, or if they are rates below cost price, or if they are excessive preferences to sugar destined for exportation. It is a difficult subject and cannot be dealt with fairly without very full and definite information.

With regard to countervailing the bounty arising from an excessive surtax, it is clear that the mere fact of the existence of a surtax exceeding six francs would not justify the enforcing of the penal clause unless it be shown that "advantages" are obtained from it.

In the case of Cuba, for instance, the surtax exceeds the six francs, but it would be absurd to penalize Cuban sugar on that ground. Cuba produces more than a million tons of sugar, imports practically none, and consumes only 40 to 50,000 tons. It would be impossible in such a case to convict the Cuban planter of obtaining a bounty from the surtax. It is therefore very necessary to lay down the clear principle that it is not the surtax but some definite advantage obtained from it that is to be penalized. The United States is another case in point though of a somewhat different kind. It gives preferential treatment to sugar imported from Cuba, Porto Rico, the Sandwich Islands, and the Philippines, and to sugar produced in its own States. But all that sugar is sold in the sugar markets of the United States at the duty paid value and is on a par with sugar paying the full import duty. This is a bounty to the producing countries and to the sugar Producers in the States, but it is no bounty to the American refiner or confectioner. It would be unfair to penalize American refined sugar unless it were produced direct in the Louisiana or the beetroot factories. In any case it would be unfair to penalize American confectionery.

This raises a further question. Is preferential treatment in the United States markets such a bounty to those foreign countries which enjoy it as could be regarded as coming within the scope of the sugar convention? The Governments of those countries do not give a

bounty to their sugar industry. The bounty is obtained solely through the action of a foreign country. The sugar produced in Louisiana and the United States beetroot factories would undoubtedly be subject to the penal clause. But what are we to do with sugar coming from countries like Cuba which are independent States, giving no bounty themselves but enjoying a preference in the markets of the United States? This is a question which will have to be decided, because there are times when the Cuban market is depressed during the thick of the crop, and when buyers outside the United States might find it advantageous to buy Cuban sugar.

We have said enough to show that there are many questions still to be settled before we can say that the convention is in complete working order.

THE COBDEN CLUB.

The persistent way in which the Cobden Club have, for more than twenty years, opposed the abolition of bounties on sugar is a remarkable instance of party politics under the guise of scientific economics. They have tried many arguments and marshalled many figures, all more or less erroneous. At first protection was their great cry; as if the restoration of free competition, the abolition of protection to foreign producers in British markets, and a return to the natural price, were identical with protection to British producers in their own markets, and the consequent creation of an artificial price and a hindrance to free competition. The fallacy seems too absurd to need refutation; and yet almost every statesman of the opposition side, Gladstone excepted, greedily took up the idea and worked it for all it was worth, even up to the debates of last year. But eventually they thought they had a better cry, cheapness. This has proved more successful and has caught on with the man in the street. Recently the Cobden Club have returned to the charge, and many papers have printed a letter from their secretary deploring the recent rise in sugar and laying it all at the door of the Brussels Convention.

True facts and arguments are of little use with the British public, while they swallow the imitation article with avidity. Still it may be worth while to state the facts. Bounties have had a wonderful effect in stimulating an excessive production of beetroot sugar, with the final result that recently the bounty-fed source of supply constituted about two-thirds of the visible production of the world. The great Cartel bounties in Germany and Austria threatened, three years ago, greatly to aggravate this artificial state of things. Stocks accumulated and prices fell to a point at which it was impossible for natural producers to maintain the competition. If no international discussion and settlement of the question had intervened, and things had been allowed to take their course, Austria and Germany would by this

time have been masters of the situation. All other competitors, even the lesser bounty-fed countries, would have been ousted, and the consumer would have found himself dependent on a very reduced and precarious source of supply.

This would, in the eyes of the Cobden Club, have been in strict accordance with the *laisser faire* policy of what they are pleased to call Free Trade. They therefore accuse the Brussels Convention of having raised the price of sugar. They maintain that a price nearly £4 a ton below the cost of production is one which the British consumer has a right to claim in perpetuity. They do not explain how that is to be accomplished, but they emphatically protest, in the name of Cobden and free trade, against any attempt to save natural competition from certain destruction. They, in fact, declare categorically that the cost of sugar ought to be governed by bounties, and that the Convention has most wickedly intervened to prevent that eminently free trade arrangement from being made permanent.

The most curious fact in this latest phase of a long controversy is that the recent rise in sugar is, in great part, positively the result of the bounties, not of their abolition. It is true that Cuba had a little unexpected shortage, and that consumption on the Continent has been greatly stimulated by the recent reduction in the sugar duties in France and Germany. But the main factor in the rise has been the drought in Austria and parts of Germany. That has created a little scare, and prices have been forced up one or two shillings by the operations of speculators. This would never have happened if there had not been the stimulation to over-production caused by bounties, and the consequent artificial preponderance of beetroot sugar in the world's supply. We should have had plenty of beetroot sugar in any case, but it would not have been so dominant a feature in the market as to cause a rise every time the roots were not quite so large as usual; nor would it ever have brought about the glut of sugar which forced prices to a point where natural production would have been destroyed if the Brussels Convention had not come to the rescue.

The paradoxes of the Cobden Club do not end here. In their recent letter they greatly deplore the fact that the Brussels Convention has caused a distinct increase in the world's consumption of sugar. This is an unpardonable sin in the eyes of the Cobden Club. To enable the unfortunate overtaxed continental consumer to enjoy at last sugar at a reasonable figure is an offence to their free trade principles. They cannot conceive it possible that Cobden and Gladstone would have regarded with favour such a consummation. To increase consumption, and thereby the demand for sugar, is a benefit to the sugar producer so scandalous in the eyes of the Cobden Club that they cannot find words strong enough to condemn it. Their

only desire is that the cost of production should continue to be governed by bounties and that the downtrodden confectioner should for ever enjoy the advantage of using sugar at a price £4 a ton below cost. It is time that they should indicate to their readers how this happy Utopia is to be obtained. In any case we thank them for their newest exposition of the fundamental principles of free trade.

SCIENCE IN SUGAR PRODUCTION.

By T. H. P. Heriot, F.C.S.

(Continued from page 435.)

4. Manufacture.—(*Continued.*)

(*d*) *Concentration and Crystallisation of the Syrup.*

Science not having yet furnished the sugar producer with a method of removing all soluble impurities from cane—and beet—juices, the preliminary evaporation, dealt with in the preceding paper, yields a syrup containing many substances in solution besides the sugar it is desired to extract.

Whereas a perfectly pure syrup would yield a residue of dry sugar by the complete evaporation of the water, such simple treatment is impossible when the liquid contains other non-volatile substances; the final stages of manufacture therefore consist in causing the sugar to assume a solid (crystalline) form whilst all the impurities remain in solution; this being followed by a mechanical separation of the sugar crystals from the liquid residue.

Before proceeding further, we must call the reader's attention to a few general principles which underlie the practical methods to be described.

Solubility.—Regarding the syrup as a strong solution of sugar, it is important to note that the quantity of sugar which can thus remain in solution is strictly limited. Speaking generally, the *solubility* of any solid in any liquid is fixed and invariable *for any given temperature* and, as a rule, increases directly with the temperature.

When the ratio of solid to liquid corresponds to the maximum at any given temperature, the resulting solution is said to be *saturated*. On raising the temperature, the solution ceases to be saturated, and is capable of dissolving more of the solid. On lowering the temperature, thereby reducing the solubility of the dissolved substance, the excess of the latter separates in the solid form, leaving the cooled liquid saturated at the lower temperature.

By way of illustration, we proceed to make a hot saturated solution of sugar by continued additions of powdered sugar to a small quantity

of boiling water until, after constant stirring, an excess of sugar remains insoluble. The clear syrup is next decanted, or filtered, into a clean glass, and, assuming the temperature to be 100° C. (212° F.) the sprup will have the composition represented under "A"

	A. 100 C.		B. 15·5 C.
Sugar	82·97	..	66·40
Water	17·03	..	33·60
	100·00		100·00
Solubility of sugar in 100 parts of water..	487·2	..	197·6

On allowing the saturated syrup to cool, small sugar crystals separate from the liquid although the latter remains fully saturated. At a temperature of, say, 15·5° C. (60° F.), the clear syrup will have the composition represented under B, the solubility having fallen from 487·2 to 197·6 per 100 parts of water present. For any other temperatures, the composition of a saturated solution of sugar can be readily calculated.

Such data are true for pure solutions only under certain normal conditions, but sugar and many substances, are capable of forming *supersaturated* solutions in which the normal solubility of the dissolved solid may be greatly exceeded, and which are generally formed when hot saturated solutions are cooled without contact with solid particles of the dissolved substance. Such particles serve as startling points or "nuclei" upon which the deposition or precipitation of the dissolved solid can proceed until the solution ceases to be supersaturated; in other words, until the quantity of substance remaining in solution corresponds exactly to its normal solubility at the temperature to which the liquid has been cooled. In some cases, the change from a supersaturated to a normally saturated condition occurs instantaneously on the addition of a minute crystal of the dissolved solid; in other cases, the change may be slowly brought about by mechanical means, such as stirring or shaking of the liquid. The most efficient plan is a combination of both methods, namely, the continued stirring of the supersaturated solution in contact with solid particles (crystals) of the substance in solution, a method familiar in sugar factories for effecting "crystallization in motion" and which will be more fully described shortly.

Crystallisation.—A very large number of solids possess the property of assuming regular geometrical forms, or crystals, when separated from their solutions by evaporation of the solvent. Crystalline form is therefore a characteristic of such substances, for example, common salt crystallises in cubes, alum in octohedra, nitre in six-sided prisms, sugar in oblique four-sided prisms, etc.

A crystal *grows* in size by contact with a solution of the same substance, an essential condition being that the solution, or mother-

liquor, should be maintained in a slightly supersaturated condition by gradual cooling or by slow evaporation. If the degree of supersaturation is great, a fresh "crop" of crystals may be formed which retard the growth of those already present. If, on the other hand, the mother-liquid is not a saturatated solution, the original crystals partially dissolve until a state of equilibrium is reached, and only commence to grow when the solution becomes supersaturated by further evaporation or cooling.

Each surface of a growing crystal receives successive layers of solid deposited from the solution so that the characteristic form is maintained although the size of the crystal may be increased almost indefinitely. During this building up process, small quantities of the mother-liquor are frequently retained as films between the separate layers or deposits, and this retention of liquid increases directly with the size, or surface-area, of the crystal, from which it follows that large crystals are generally less pure than small ones.

Crystallisation is an essential operation in many industries, more especially in those classed as "chemical industries." Two or more crystallisable solids can be readily separated, if their crystalline forms are dissimilar, by taking advantage of their unequal solubility in a given solvent, such as water; the less soluble separating at a lower degree of concentration, or at a relatively higher temperature, than the more soluble substances. Thus, by the gradual evaporation of a complex solution, the various dissolved ingredients may be partially separated by removing the crystals deposited at various stages. Each deposit, or "crop" of crystals will then mainly consist of one ingredient with a small admixture of other crystals, and may be sufficiently pure for commercial purposes. When it is desired to separate the ingredients in a chemically pure form, the various crops of crystals have to be separately dissolved in water, or other liquids, and recrystallised; these operations being sometimes repeated several times.

Sea water is an example of a complex solution of several crystallisable substances in addition to the familiar table-salt, which is its main solid constituent. The first effect of evaporating this liquid is to separate about one per cent. of fairly pure table-salt, containing traces of sulphates of lime and magnesia. Continued evaporation yields a deposit having a bitter taste, owing to the larger proportion of sulphate of magnesia crystallising along with the table-salt. If the evaporation be carried further, chlorides of magnesia and potash are deposited, and, formerly, the evaporation was continued to this final stage in order to extract the valuable potash salts, which are now obtained much more cheaply from natural deposits.

The crystallisation of sugar from syrup is a much simpler operation for, if we neglect traces of saline impurities, the sugar is the only crystallisable substance present in the syrup. Yet it is practically

impossible to obtain crystals of pure sugar by the direct evaporation of cane and beet syrups, owing to the viscous and gummy nature of the mother-liquor adhering to the surfaces of the crystals and also partially retained in their internal structure.

Such sugar, containing from 96 to 98 per cent. of pure sucrose, constitutes the raw material of the sugar refiner, who melts and re-crystallises it before it reaches the consumer in the form of loaf-sugar. The latter still contains about 0·5 per cent. of impurities, consisting mainly of moisture, but requires further treatment before the sugar can be rendered absolutely pure.

The Beet.

Resuming the subject of evaporation, we now approach the critical stage at which the sugar makes its first appearance in the crystalline form; for, as evaporation proceeds, the ratio of sugar to water increases until the syrup becomes first a saturated, then a supersaturated solution, from which sugar readily crystallises. Continued evaporation of water causes an increasing proportion of sugar to crystallise, until, finally a semi-solid magma is obtained consisting of a mixture of sugar crystals and mother-liquor.

Whereas the concentration of the juice by multiple-effect evaporation requires very little attention, the subsequent concentration of the syrup constitutes the "art" of sugar making and can only be conducted by trained operators. In this department of the Sucrerie, Howard's Vacuum Pan finds its special application; this simple type of evaporator being under more complete control than the multiple-effect apparatus, and possessing other practical advantages.

The reader will now perceive our object in treating the concentration of the juice in the multiple-effect as a distinct and preliminary operation to the concentration of the syrup in the vacuum pan. In the former stage from 85 to 90 per cent. of the total water is evaporated with a minimum consumption of fuel, leaving a relatively small proportion to be evaporated from the syrup in the vacuum pan.

A secondary effect of concentrating the juice to syrup is the precipitation of certain mineral impurities which were soluble in the original liquid. These are deposited as an incrustation adhering to the heating surfaces of the evaporator, and also form a precipitate in the syrup, rendering the latter turbid. Mechanical filtration is therefore essential to clarify the syrup before it passes to the vacuum pan, and the Phillipe filter is specially adapted to this purpose.

The Vacuum Pan.—The theory of evaporation in vacuo having been dealt with, we may now examine the construction and operation of the vacuum pan. Howard's apparatus, patented in 1813, possessed all the essential features of modern pans, but differed mainly in the heating arrangements. The earliest pans were fitted with a double-

bottom, or steam jacket, having a relatively large heating surface compared with the volume of the contents of the pan, enabling low pressure steam to be used as a source of heat without risk of charring the syrup undergoing evaporation. This design necessitated a very shallow form of vessel, of small working capacity, and more especially suited to the requirements of small factories. Howard increased the heating surface of his pan by introducing a spiral steam-coil inside the pan in such a manner as to be covered by the boiling liquid. This latter method of heating has since been much elaborated, and to-day the steam-jacket has been superseded by a series of coils arranged one above the other, and presenting a total heating surface which may amount to over 3,000 square feet in a very large pan. But the ratio of heating surface is rarely sufficient to allow of the use of low-pressure steam alone; the modern pan being distinctly inferior to Howard's original apparatus in this important detail. Some minor improvements have been made in the arrangement of the coils to facilitate repairs and to allow of the rapid removal of water of condensation, but the general designing of the vacuum pan has not kept pace with the rapid improvement of the multiple-effect evaporator.

The pan is now generally constructed of cast iron in the form of a vertical, cylindrical vessel, surmounted by a dome or conical top, and having a conical bottom terminating in a central discharge opening, of large diameter, closed air-tight by a sliding door. The heating surface consists of four, or more, independent coils fixed in the interior of the cylinder at different levels. One extremity of each coil passes through the side of the pan and communicates with the steam main by a valve; the water condensed in the coil escapes through a pipe leaving the lower part of the pan, and is automatically discharged through a trap which maintains the required steam pressure in the coil. The vapour, rising from the boiling syrup, escapes through a wide vapour pipe at the top of the pan into a safety vessel which retains any entrained liquid, and passes thence to the condenser. The latter apparatus and the vacuum pump need not be specially described.

The "proof-stick," also invented by Howard, enables small samples of the contents to be withdrawn for examination, without allowing air to enter the vacuous interior of the pan. The syrup to be evaporated is supplied through a feed pipe, controlled by a valve, and the pan is emptied through the discharge door at the bottom. In order that the pan-boiler may see the level of the liquid he is boiling, a number of windows or "sight-glasses" are fitted into the side of the pan at different levels. The degree of vacuum in the pan and the steam pressure in the coils are suitably indicated by guages; also the temperature of the boiling syrup by a thermometer. Finally, a large cock admits air to the pan when the boiling operation is completed.

Horizontal types of pans have found favour in Austrian factories, and possess certain advantages over the more general vertical type.

Boiling the Syrup.—All communications between the interior and exterior of the pan having been closed, and the pumping engine started, the air is gradually exhausted from the interior of the pan until the guage indicates a vacuum corresponding to about 25 inches of mercury. The syrup valve is then opened until the lowermost steam-coils are completely covered, steam being then turned on to the latter, and cold water admitted to the injection pipe of the condenser. The syrup is thus rapidly heated until it boils at a temperature corresponding to the vacuum in the pan. Fresh additions or "charges," of syrup are made at short intervals; steam being admitted to each coil in turn as soon as it is covered by the rising level of the contents of the pan. At this stage the syrup is boiled under precisely the same conditions as in the last vessel of the multiple-effect evaporator. But, as evaporation proceeds, and the syrup approaches the crystallising point, the pan-boiler commences to draw samples from the pan by means of the proof-stick, the appearance of the sample enabling him to judge when the syrup has become a supersaturated solution of sugar.

Graining.—The formation of crystals, technically termed graining, is now brought about by suddenly lowering the temperature of the pan. This is done by admitting a more copious supply of cold injection water to the condenser, which has the effect of increasing the vacuum in the pan, and thus lowering the boiling point of the syrup. The latter, which was supersaturated at the higher temperature, can now no longer retain the whole of the sugar in solution, and deposits the excess in the form of minute crystals. At frequent intervals, the pan-boiler withdraws samples of syrup from the pan, which he pours upon a glass plate and examines in a strong light; a sparkling appearance of the syrup informing him when the grain has formed, (the crystals being yet too minute to be detected by the sense of touch) and his experience enables him to judge when the crystals are sufficiently numerous to yield, when fully grown, a properly crystallised product. When this critical stage is reached, more syrup is drawn into the pan, and the temperature slightly increased by reducing the supply of injection water to the condenser, and slightly lowering the vacuum in the pan.

If the pan-boiler aims at making large crystals, or coarse-grained sugar, he conducts the foregoing operation with a relatively small volume of syrup, or, as he expresses it, he grains low in the pan, at the same time avoiding the formation of too many crystals. By gentle boiling of the pan, he then coaxes the crystals to grow at the expense of the sugar dissolved in the syrup, which he supplies at regular intervals. When medium or small-grained sugar is desired,

the graining operation may be conducted when the pan is from half to three-quarters full. In this case it is necessary to boil rapidly with frequent additions of small charges of syrup.

Feeding the Pan.—This operation consists in causing the grain to grow without forming any new grain; a second granulation, or "false grain," being a sign of careless work and resulting in a loss of sugar at a later stage. The pan is gradually filled by frequent small charges of syrup, steam being admitted to each coil as soon as it is covered.

The boiling of the material is accompanied by a thorough circulation of the contents of the pan so that each charge of fresh syrup is rapidly distributed throughout the boiling mass and brought into intimate contact with the crystals. The pan-boiler has therefore to maintain the syrup, or mother-liquor, in a slightly supersaturated condition by carefully controling the temperature and vacuum in the pan, and the degree of concentration of the liquid circulating between the crystals. The sugar, added to the pan in the form of syrup, is then deposited upon the original crystals, which steadily increase in size and cause the boiling mass to stiffen considerably. Whilst the pan is thus being filled, the proof-stick is in constant use in order to observe the regular growth of the crystals which should be fairly uniform in size; also the consistency of the mother-liquor, which should neither be too viscuous nor too thin. As soon as the pan is filled to the level of the uppermost sight-glass, the supply of syrup is stopped.

Concentration of the Masse-cuite.—A proof-stick sample from the pan now presents the appearance of a mass of well formed crystals imbedded in a relatively small proportion of mother-liquor; this mixture being termed "masse-cuite." The final stage of the boiling has for its object to reduce the proportion of this liquid to a minimum by slow and careful evaporation in order that the sugar remaining dissolved in the mother-liquor may deposit upon the crystals present.

It being, however, impossible to evaporate the whole of the water from such semi-solid material, the limit to which this concentration can be pushed can only be learned by experience, and depends upon the following considerations. The finished masse-cuite must not be too stiff, otherwise difficulty will be experienced in getting it out of the pan when the bottom door is opened. Again, the mother-liquor must remain sufficiently fluid to be capable of mechanical separation from the crystals at a later stage.

Discharging the Pan.—The boiling process being now completed, all steam valves are shut, the pumping engine stopped, and air admitted to the pan through the air cock. On opening the large discharge door at the bottom, the finished masse-cuite falls into a receiver

placed below. The pan is finally steamed out to remove the sugar adhering to the internal surfaces, and is then ready for a fresh start.

Instead of discharging the whole contents of the pan and recommencing the above series of operations, it is often more convenient to utilize a portion of one charge of masse-cuite as a foundation for the next; more especially when the grain of the masse-cuite is small. Under these conditions, the sugar crystals present in the pan form "nuclei" upon which sugar is deposited during the evaporation of fresh additions of syrup. The operation of graining is therefore avoided, but the subsequent boiling and feeding of the pan is continued as before. By this method, known as cutting or doubling, the size of the crystals increases each time the pan is "cut"; and from one granulation several charges of crystallised masse-cuite can be worked up.

When discharged from the pan the masse-cuite has approximately the following composition, from which it will be seen that about 25 per cent. of the total crystallisable sugar remains in solution in the molasses:—

		Per cent.
Sugar crystals (pure sucrose)		63
Molasses	Soluble sugar	22
	" impurities	9
	Water	6
		100

As the manufacturer cannot afford to leave sugar in his molasses when it is possible to extract it, we have next to consider a second application of the vacuum pan.

The evaporation of water from the crystallised masse-cuite being only partial, for reasons already stated, it will here be necessary to anticipate the subsequent separation of the crystals from the molasses, to be described in our next paper.

The molasses, freed from the sugar crystals, form a very viscuous, saturated solution of sugar containing also, in a highly concentrated form, all those impurities of the original juice which were not removed during carbonatation or other methods of purification.

After a preliminary treatment with milk of lime and steam for the removal of suspended impurities by skimming, the molasses are drawn into a vacuum pan and concentrated by continuous boiling. Unless exceptionally pure, the molasses cannot be grained in the pan but are there merely concentrated to a point at which the sugar is retained in a supersaturated solution. The pan is then emptied into tanks, or coolers, in which crystallisation takes place very slowly as the material cools. The resulting crystals are much smaller than those yielded by the original syrup, and are sold as low-grade sugar. The mother-liquid separated from these crystals forms a "second" molasses which, when re-boiled and cooled, yields

a small quantity of "third sugar," and a greatly reduced volume of molasses from which no more crystals can be profitably recovered.

Before dismissing the subject of vacuum pan work, we may remark that the mysterious "art" of the sugar-boiler is slowly yielding to scientific methods; Dr. Classen having drawn up a table indicating the percentages of water in the mother-liquor at different temperatures, based on numerous analyses of beet-molasses. This table, used in conjunction with the thermometer and barometer, attached to the pan, enables the operator to control the degree of concentration at various stages of the boiling.

The treatment of syrup in the vacuum pan affords an illustration of the formation and growth of crystals in a boiling solution, whereas in the subsequent treatment of re-boiled molasses we find that crystallisation occurs only on cooling. The latter case is due to a retarding influence of impurities on the crystallisation of sugar, which causes the molasses to retain their supersaturated state after cooling considerably, and even after crystallisation has commenced.

Formerly, the re-boiled molasses were cooled at rest in open tanks, in which they were allowed to remain for three or four weeks, in order to ensure a maximum yield of crystals. To-day the products of the vacuum pan are crystallised in motion, with great economy of time and increase in yield.

From theoretical considerations, we have seen that supersaturation is mainly due to the absence of contact between a solution of a solid and the solid itself. *Crystallisation in motion* causes the sugar crystals to continually change their positions, thus bringing each crystal into intimate contact with different portions of the supersaturated mother-liquor. The latter then parts more readily with the excess of sugar it holds in solution, depositing same upon the crystalline surfaces with which it comes in contact.

In the practical application of these principles, the beet industry has again led the way and brought the method to perfection. The stirring apparatus is an horizontal cylinder which can be slowly rotated on its axis; or, the cylinder is stationary and carries a central shaft to which stirring paddles are attached. The cylinder may be either of the open or closed types, and may also be heated or artificially cooled by introducing steam or cold water into a jacket on the exterior of the cylinder.

When applied to the treatment of syrup-masse-cuites, crystallisation in motion greatly increases the yield of first sugar at the expense of low-grade sugars, and yields a very fluid first molasses free from small grain. A still more effective application is in the treatment of re-boiled molasses which, when cooled in motion, yield up their crystallisable sugar in a few days instead of weeks; the resulting low-grade sugar being more easily cured and of better quality than when crystallisation occurs at rest.

Numerous modifications are made in the method of working the vacuum pan and crystalliser which cannot be referred to here; we are also obliged to pass over several interesting processes which have been applied to the more perfect extraction of sugar from molasses.

The Cane.

The vacuum pan met with equal success in the West Indies after its value had been proved in the beet sucrerie. Although the first departure from ancient custom, this costly apparatus soon convinced proprietors that their investments yielded a handsome profit in the quantity and quality of the sugar produced. But, until the multiple effect evaporator made its appearance many years later, the evaporation of the juice to syrup was continued on the Copperwall, and the advantages of evaporation in vacuo could not be fully realised.

Crystallisation in motion has long been applied to cane-products in Java, but the adoption of this process in the West Indian industry is of comparatively recent date. In addition to the advantages described above, the crystalliser in motion is a labour-saving invention which has completely revolutionised this department of the modern cane factory. The semi-solid products of the vacuum pan can now gravitate from floor to floor, the finished sugar being bagged off on the ground-level. The negro sugar-digger is fast becoming an extinct animal and, if not paid off, is exerting his muscles amid cleaner surroundings.

The operations of boiling and crystallising cane products are identical with those described under "the beet," although the final products differ considerably. The sugar crystals, when cured, always retain traces of the molasses which cannot be completely separated and therefore impart their characteristic odour and flavour to the raw sugars of the two industries.

As regards the uncrystallisable residues, or final molasses, the following comparative analyses by Gill will sufficiently indicate that the nature of the accompanying impurities has a marked influence on the quantity of sucrose which cannot be recovered in a crystalline form:—

Chemical Composition of Molasses.

	Cane.	Beet.
Sucrose	35·0	49·0
Glucose	32·0	3·0
Saline impurities	5·5	12·5
Organic impurities	9·5	15·5
Water	18·0	20·0
	100·0	100·0

(*To be continued.*)

THE RELATIVE MERITS OF CANE AND BEET SUGAR.

In our July number we discussed the relative merits of cane and beet sugar, and reproduced the opinion of an analytical chemist on the subject, as supplied to us by Messrs. Crosfields, Ltd. Mr. F. L. Scard, of Demerara, now writes to the *West India Committee Circular*:—"The remarks of Messrs. Richardson and Morris are of special interest to me, inasmuch as the question of the sweetness of sugar came forcibly before my notice upwards of twenty years ago. The late Mr. E. E. Francis, the then Government Chemist of British Guiana, was anxious at that time to obtain a sample of chemically pure sugar for use for polariscopic corrections. We accordingly procured some ordinary Demerara crystals washed until practically white in centrifugals, and purified these by successive crystallisations and washings with alcohol and ether. The final product, small in grain, was chemically and physically cane sugar, *but was quite tasteless*. We came, therefore, to the conclusion that the sweetness of ordinary cane sugar was due to some flavouring constituent of the cane juice still clinging to the sugar—in other words that sweetness was an impurity and not a property of sugar.

"The superiority claimed for cane sugar is quite explicable looked at in this light. In the preparation of raw cane sugar—apart from the question of Demerara yellow crystals, where special procedure is adopted to preserve the flavouring characteristics of the juice—a comparatively small amount of lime is used. The flavour of the juice is thus less destroyed than with the beet processes, and in this way, whether alkaline carbonates are present or not, the sweetness of beet sugar is inferior to that of the cane. Comparison as regards smell between raw cane and raw beet shows this to a very marked extent."

In the *Journale d'Agriculture Tropicale*, for June, M. George de Preaudet, discussing the same subject, concludes:—

"It is evident that of all refined sugars the purest is white cane sugar. For if this were identically the same as white beet sugar, as is held by some authorities, why is it that the large manufacturers of champagne require their sugar dealers to give them a formal declaration that they never allow into their works a single bag of beet sugar? Experience has shown that wines sweetened with beet sugar always give an after taste of beetroot.

"A very easy test is carried out as follows: Take two glasses containing moistened sugar—one beet and the other cane. Cover both with saucers and allow them to stand for some days. If they are tasted at the end of that time, it will be found that the beet sugar has assumed a taste of beetroot and also emits a slight odour."

THE PRESENT POSITION OF SUGAR.

By Sigmund Stein.

(Sugar Expert, Liverpool.)

In the history of the sugar trade we have not had a year like that of 1904. After the stagnation existing for several months at the beginning of the year, the sugar market got feverish and prices jumped up and down, and are still fluctuating rapidly. Report upon report with figures and statistics floods the market. Abroad there is at present apparently only one article which interests the speculator; which is sugar. The gambling spirit embarrasses not only people interested in the sugar trade but others who use this commodity as an article of consumption. The man in the street, the servant girl, the clerk, the merchant, the manufacturer, and all who have some money to lose gamble on sugar futures. How will such a speculation end?

We have seen before that the gambling in the sugar trade does not improve it, but tends to make it a dangerous one. If someone has burnt his fingers in sugar he will not touch it again, not listen to anything said about it. It is a pity that a general article *par excellence* as sugar is, should be so speculated with.

I have been repeatedly asked what I think about the matter and I advise everybody who is not in the trade, and who is not inclined to lose, to be very careful. We have before us statistics which assert that the sugar beet crop of Europe will be a failure. Is that failure enough to bring prices up to a level wherefrom they must drop very suddenly or bit by bit cause a smash and bring many persons to ruin? After every great storm comes a calm. We have just entered on the beet campaign abroad. The sugar beet is not harvested yet, and it will take weeks before we can get a real idea as to how the European beet crop will shape. In former times we had a few celebrated statisticians, men of great experience, and whose estimates generally agreed with the actual crop. But nowadays everybody is a statistician. Everybody "knows" at present that the sugar beet crop is a failure, and that there will be no sugar available for table use.

On a business tour which I have lately made through the Continent of Europe I had occasion to inspect the beet fields and talk the matter over with the farmers and manufacturers. I pulled out the beets, and I saw very good beet crops. I never saw the devastated lands, nor the empty spaces, nor the small dwarfy roots of which the people speak, dream, and speculate about. What I have seen is that the beets have been very much refreshed by the alternations of rain and sunshine. The analyses published by the different parties on the Continent show that the sugar beets are very much richer in the

saccharine contents and quotient of purity. I did not find the dried roots of which so much is spoken of by outsiders and people of outside trades. I admit that the sugar beet crop will be smaller this year than in previous years. But is there any sane reason why prices are forced up to a pitch from which they must shortly drop to cause the ruin of many? Is there any reason for raising the prices so high that they will cause a subsequent over-production of sugar? And this over-production will occur in every country next year, thus accentuating a crisis the like of which has not been seen before. The men at the bottom of this are merely outside speculators, people who are always sellers, who will sometimes realize and then unsettle the market.

There has been some talk on the Continent of several old factories with obsolete machinery becoming dismantled, but the present position of sugar seems to have caused their owners to change their minds. The latest rumour is that instead of dismantling, such factories intend to work again. But the life of such obsolete establishments will only be prolonged for one year and then they will succumb in the subsequent season to those modern factories which have so many advantages over them.

It is regrettable that the sugar business is in such a desolate and unsettled state. What use are the bids of a first party when second and third parties offer very much cheaper prices? Imagine the state of things prevailing now when every sunbeam and every drop of rain, as it were, regulates the market.

The year 1904 has had the best fruit crop for many years. The fruit is so cheap, not only in this country but in America and on the Continent, that the fruit growers cannot cover the expenses of gathering from the prices received, and so much fruit is left ungathered. We should have thought with such an abundant fruit crop that the increase in the consumption of sugar would have gone up by leaps and bounds. But we find that from September 1st, 1903, to September 1st, 1904, we consumed 1,409,757 tons of sugar in the United Kingdom, whereas, in the same period of the previous year we consumed in this country 1,460,450 tons, and two years previously, 1,738,261 tons. Such figures speak for themselves.

The reason of this decline may be bad trade and the high price of the sugar. It may be also that the constant fluctuations in the prices of sugar have deranged the market. The figures just mentioned are very disappointing, because the figures for the Continent show an increase in the consumption.

But we must not forget that the world has two hemispheres. The failures in one hemisphere may be counteracted by favourable crops in the other, hence we are glad to hear that the cane crop will be

successful this year and will moreover be 400,000 tons larger than the previous one.

The prices caused by the imaginary famine in Europe will bring about an increase in the production of cane sugar and so we may expect next year a record crop and a record slump in prices which will be a good lessoon to all persons who artificially and wilfully unsettled the market this year.

THE DEPORTATION OF KANAKAS.

The question of the deportation of kanakas is one which, sooner or later, is bound to come up for revision. The other day the Governor-General of the Commonwealth was personally petitioned by some 200 islanders who had made permanent homes in Queensland, the purport being that they should not be sent back to the places of their birth in the South Sea Islands. These people, however, only represent one side of the question. They have resided in Queensland many years, they have married, reared families, acquired property, and, in short, have taken their places as members of the Queensland community, differing only in the colour of their skins from the rest of the people. To compel them to sacrifice their homes and take themselves and their useless capital to the semi-civilised islands of the Pacific would be the height of barbarity and an impossible thing to seriously contemplate. It is therefore without surprise that we note that the Minister for External Affairs has at once made a statement of a reassuring nature. In that statement he has reiterated the promise made by the late Prime Minister to the Imperial Colonial Office to the effect that all consideration shall be given to every exceptional case, and that injustice will be avoided. But he has gone further. He has expressed the opinion that, even if the law is not mandatory, its intention is that all kanakas shall be deported as soon as possible after 1906. Such being the case he holds that the Federal Parliament will have to be consulted and possibly an amending Act, for the purpose of dealing with those special cases, introduced. There is little question that the debate which would thus be raised will travel further than the discussion of the cases of the kanakas who petitioned Lord Northcote. As we have said above, these people only represent one side of the question, though possibly the side which makes the greatest claim upon the humanity of Australians. When the question comes before the House of Parliament, not only must the claims of Rockhampton be considered but also those of kanakas of other parts of the State. The legislature will also have to decide, exactly what constitutes an exceptional case worthy of consideration. Many kanakas who are not married still possess considerable property, the transfer of which to the South Seas

would render it practically useless. The mere fact that kanakas have married white women, as many of the petitioners have, would appear to be an argument against rather than in favour of their remaining in Australia, if there are any real grounds for believing that the purity of the nation of the white Australian race is threatened. Yet to allow these married kanakas to remain and to deport those who have not married would appear to be a somewhat anomalous proceeding. Yet again one may well ask whether Australia is going to limit her exercise of humanity towards kanakas only and is not prepared to take into consideration the claims of many thousands of white people who have settled on the Northern tropical coast line. Sufficient has been seen already of the white labour experiment to show that its final solution cannot be looked for by the end of 1906. It is true that some progress has been made under the stimulation of the bonus on cane, but it is also true that many farmers are preparing to leave their homes as soon as the bonus terminates. It is further not unreasonable to think that, so long as the bonus is assured for three or four years ahead, cane cultivation will be maintained and an ever increasing proportion of white men employed. Not only therefore from a sense of humanity towards the kanakas and also towards their fellow Australians, but, even as a political and business proposition, the statesmen of the Commonwealth should consider whether it would not be wise to altogether suspend the deportation of kanakas for at least three or four years beyond the present term. It is certain that every year, now that the importation of kanakas has ceased, will see a diminishing number of these people in our midst. Some will die and many will return to their islands. Those who remain will in reality represent those to whom an injustice will be done if they are forced to leave the Commonwealth. Yet it is this very residue upon which the cane growers of the more Northern centres must depend until there is an ample supply of white labour.—*Mackay Sugar Journal.*

Next year's crop at Chaparra, Cuba, is expected to reach 450,000 tons of cane.

Mr. Hedemann of the Honolulu Ironworks has just designed and constructed an automatic juice weighing machine. This machine is said to simplify chemical control to a great extent and to accurately register the weight of any liquids flowing through it.

The following statistics of cane farming in Trinidad for 1904 are of interest. Number of farmers: East Indian, 4,575; West Indian, 4,441; total sugar made, 46,029 tons; estate canes ground, 330,448 tons; canes purchased, 167,161 tons; amount paid for canes, $349,330.

CHEMICAL CONTROL IN USE IN THE JAVA SUGAR FACTORIES.*

By H. C. Prinsen Geerligs,
Director of the West Java Sugar Experiment Station at Pekalongan.

(Continued from page 444.)

B.—MONTHLY REPORT.

The figures from the daily report A. are entered into books B. and C. in order to serve as material for the compilation of the monthly report. Some prefer to make this report every week or every ten days, others once a fortnight or month, but for convenience sake in this treatise only, the term monthly report is mentioned without attaching too much significance to the word "monthly" because a weekly report is calculated in exactly the same way.

1. Cane.

(*a.*) *Weight of the Cane.*—The weight of the cane crushed is taken to be the weight of the cane entered into the factory yard after deduction of the weight of the cane still left uncrushed at the moment of the date of the report.

(*b.*) *Sucrose.*—In this report the value s.f.m.j. × Factor may no longer be used, as this was only tolerated in practical use for a rather rough estimation of the constitution of the cane. Add the weight of sucrose entered in juice into the factory to the weight of sucrose lost in bagasse during the month and divide that sum by the weight of the canes crushed, after which the quotient is to be multiplied by 100.

This same calculation is repeated with the total weight of the sucrose from the beginning of the grinding season in order to have the average for the whole grinding time as well.

(*c.*) *Fibre.*—This figure may be calculated by dividing the sum of the percentages by the number of observations.

2. Bagasse.

(*a.*) *Sucrose.*—When calculating the total weight of sucrose lost in bagasse a small correction is necessary. The daily figures for that value have relation to the calculated weight of cane crushed and since we saw that this differs from the actual weight of the cane it requires a small correction. To that end the total amount of sucrose lost in bagasse during the month as recorded in the Book B. is to be multiplied with the actual weight of the cane crushed that month and divided by the calculated weight, the resulting quotient is then the actual weight of sucrose lost in the month under review in bagasse.

The fibre content may be calculated as is described on page 382. The calculation is based on the average dry substance and the sucrose content of the bagasse and the average purity of the last mill juice during the month.

3. First and Last Mill Juice, Clarified Juice Syrup, First and Second Masse-Cuites.

With the above products, none of which form fixed points for the control we can content ourselves with calculating the average by dividing the sum of the daily figures by the number of days.

4. Mixed Juice.

As the mixed juice is the starting point of the control it is necessary that the figures for that material be recorded with the utmost care. The best method is the following: add up the weights of sucrose entered in juice during the period under review and do the same thing for the weight of the mixed juice and for the weight of available sugar. Now divide the weight of sucrose indicated in juice by the weight of mixed juice and multiply by 100 in order to obtain the percentage of sucrose in mixed juice during that time. Further divide the weight of calculated available sugar by the weight of sucrose indicated in juice and multiply by 100. The resulting product is 100 times the factor of $1{\cdot}4 - \frac{40}{quotient}$ and herefrom the quotient of the mixed juice may be found by using a table in which the proportion of the factor and the quotient is recorded. From the figures of sucrose and quotient the average Brix of the mixed juice is easily found. The glucose content can be calculated by simply dividing the sum of the daily figures by the number of observations.

5. Filter Press Cakes.

Of this material a well calculated average is required, which may be obtained by dividing 100 times the weight of sucrose lost in filter press cakes during the period under review by the weight of the cakes themselves discharged during the time.

6. Sugar Delivered, Second Sugars, Sugar Returned into the Juice.

For all these products the sum of sucrose contained in them is to be divided by the weight of every product and multiplied by 100 in order to yield the average sucrose content of these materials.

7. Molasses.

The molasses drained off from the last product in the centrifugals can be easily measured and analysed. From the specific gravity and the sucrose content the quantity of sucrose removed from the manufacture can be calculated and noted in the list.

8. MACERATION WATER.

Calculate the quantity of imbibition water from the degrees Brix of first-mill juice and mixed juice after the formula developed below. Suppose the weight of maceration water=x, then the weight of normal juice is w.j. – x, and as the weight of total dry substance in both juices is the same, we have this equation:—

$$w.j. \times b.i. = (w.j. - x) \times b.$$
$$w.j. \times b.i. = b. \times w.j. - b. \times x.$$
$$x = w.j. \times \frac{b. - b.i.}{b.}$$

9. PERCENTAGE OF NORMAL JUICE EXTRACTED ON 100 CANE.

In the monthly report this value is calculated by multiplying the weight of normal juice (w.j. – maceration water) by 100 and dividing by the weight of the cane crushed. This was not feasible when calculating the daily report, and therefore another way of calculating the quantity of normal juice extracted on 100 cane was followed there.

Both figures are calculated from different values, having each their source of error, and thus they cannot be expected to give identical results. If the two figures, however, differ considerably, then it is an indication that something is wrong and wants correcting.

10. EXTRACTION.

The same calculation as sub "daily report."

C.—FINAL ACCOUNT OF SUCROSE EXTRACTED AND LOST.

At the conclusion of the grinding season and also occasionally after a stoppage which allowed the stock of cane to be worked off, the final account can be made of the profit and loss of the sucrose from the cane. The total weights of sucrose in cane, in bagasse, in mixed juice, in filter press cakes, and in molasses are known and are entered in the A. Form provided. By multiplying by 100 and dividing by the weight of the canes crushed, these are further calculated on 100 parts of cane and finally the remaining blanks may be filled in for the different products.

If e.g. a quantity of 594,749 piculs of mixed juice were recorded with 81,481 piculs of sucrose the sucrose content of that juice would have been: $\frac{81481 \times 100}{594749}$ and so on.

The figure for "unaccounted for" loss is found by subtracting the determined losses from the total loss.

Finally, calculate all weights by multiplying by 100 and dividing by the figure for weight of sugar indicated in the cane into the value for sucrose lost and gained on 100 parts of sugar in cane, and fill them in in the proper column.

Verification of Measuring Tanks and Instruments.

1. Measuring Tank.

First of all determine the contents of the 50 litres measure by filling it to the brim with water of the prevailing temperature, then weigh it on the sugar delivery scale, empty it and weigh it again still moist with the adhering water. The difference in weight represents the weight in kilogrammes or pounds of the water measured by it at the temperature prevailing in the factory.

Now fill the measuring tank with water, empty it and fill it, still wet, with water to the mark, first with the verified 50 litres measure and the last portions with a litre flask. The temperature of the water should of course be the same as when verifying the measure.

The weight of the water occupied by the tank at say T degrees C. is calculated on the weight of water of 17·5° C. which the tank can contain by multiplying the weight

for 25° C. with 1·0016
for 26° C. with 1·001
for 27° C. with 1·00215
for 28° C. with 1·0024
for 29° C. with 1·0027
for 30° C. with 1·0030
for 31° C. with 1·0033

and thus find the capacity of the measuring tank expressed in weight of water at 17·5° C., which has only to undergo a further correction for the volume of included air and froth.

A few times during the grinding season fill the measuring tank in the ordinary way to the mark and leave the juice till the froth is settled, the bubbles of enclosed air have escaped and the temperature of the warm juice is fallen to the temperature at which the tank had been previously verified. Add juice from litre flasks into the tank till the surface has reached the mark again and note the amount of juice required; this is the correction for scum, air, and increased temperature. Suppose it had required 1·5% of the volume to compensate for the shrinkage, then we can correct the determined weight of the water at 17·5° C. by multiplying it with 0·985. This figure is used for the calculation of the weight of the mixed juice, without further correction, as all corrections are already incorporated in it.

The weight of the juice daily measured becomes like this:—

Suppose the specific gravity of water of 17·5° C. to be=1. Next note during some consecutive days the temperature of the mixed juice and calculate the average. Suppose this temperature to be 31° C. and the corrected Brix—(*i.e.*, the average Brix which a Brix hydrometer verified at 17·5° C. would show in the juice cooled down to 17·5° C.) of a certain day to be 15·93, then the average Brix of that

day calculated on the prevailing average temperature is according to the table of correction 15·93 − 0·94 = 14·99, corresponding with a specific gravity of 1·0163.

The weight of the juice measured = the weight of the water at 17·5° C. corresponding with the number of tanks × the specific gravity of the juice at 31° C.

2. Measuring Flasks for the Polarisation.

The generally used Schmidt and Haensch polariscopes are so constructed that they show the 100 point, when 26·48 grammes of dry and perfectly pure sucrose weighed in the air and with brass weights are dissolved at 17·5° C. in water to a volume of 100 c.cm. after Mohr and polarised at that same temperature in a 200 mm. tube.

The flasks used for dissolving sugar solutions for the polariscopical test must therefore be graduated and verified at the temperature of 17·5° C., and must be based on the specific gravity of water of 17·5° C. = 1 as the c.cm. after Mohr means volume of 1 gramme of water at 17·5° C. weighed in the air with brass weights.

When verifying a 100 c.cm. flask we therefore weigh in the dry flask in the air with brass weights at the temperature of 17·5° C. exactly 100 grammes of water of that same temperature and mark the place where the water stands in the neck. As, however, the temperature of the tropics renders this operation at 17·5° C. impossible, or at least troublesome, a table of the weight of water of different temperatures also weighed in the air with brass weights is given below in order to enable the verification of the flasks at other than 17·5° C.

Temperature.	Weight of 50 c.cm. after Mohr. 17·5° = 1.	Weight of 100 c.cm. after Mohr. 17·5° = 1.
25° C.	49·916	99·833
25·5° ,,	49·910	99·820
26° ,,	49·903	99·807
26·5° ,,	49·896	99·793
27° ,,	49·890	99·780
27·5° ,,	49·883	99·767
28° ,,	49·877	99·754
28·5° ,,	49·870	99·740
29° ,,	49·863	99·727
29·5° ,,	49·857	99·714
30° ,,	49·850	99·701

Of late years the real c.cm. has been adopted again for the measuring flasks. It contains one gramme of water at 4° C. weighed in vacuo, and is thus smaller than c.cm. after Mohr.

The standard weight for such flasks is accordingly smaller, and amounts to 26 grammes of pure and dry sucrose, weighed in the air with brass weights.

The weight of water at different temperatures of 50 and 100 real c.cm. is recorded here :—

Temperature.		Weight of 50 real c.cm. $4^\circ = 1$.		Weight of 100 real c.cm. $4^\circ = 1$.
25° C.	....	49·802	....	99·604
25·5° ,,	....	48·796	....	99·591
26° ,,	....	49·789	....	99·578
26·5 ,,	....	49·783	....	99·565
27° ,,	....	49·776	....	99·551
27·5° ,,	....	49·769	....	99·537
28° ,,	....	49·762	....	99·523
28·5° ,,	....	49·754	....	99·509
29° ,,	....	49·747	....	99·494
29·5° ,,	....	49·740	....	99·480
30° ,,	....	49·733	....	99·465

Flasks of 50/55 and 100/110 used for juice after addition of subacetate of lead need not exactly contain 50 or 100 c.cm.; the only thing required is that the volume between the two marks be exactly $\frac{1}{10}$ of the volume under the lowest mark.

3. PIPETTES.

The best are those with two marks; verify them by the direct weighing of the contents between the two marks.

For pipettes of 100 or 50 c.cm. a difference of 0·1 % is tolerated; for smaller ones, one of 0·25 %.

4. BRIX HYDROMETERS.

The Brix hydrometers are based on the specific gravity of water at 17·5° C. = 1. Every factory should be equipped with one set of well controlled hydrometers used as standards only in order to verify those in practical use in the laboratory. If perhaps hydrometers of 17·5° C. are not at hand, those of another standard temperature may as well be used, provided a correction be applied. Suppose we test a sample juice with two hydrometers, A. and B. of which A. is based on the temperature 17·5°, and B. 27·5° C. The temperature of the juice is supposed to be 30° C., then if the readings of A. are 14·62, the real Brix is 14·62 + 0·87 = 15·49, and B. will show 15·3, or a real Brix of 15·3 + 0·19 = 15·49 or the same figure. Both hydrometers give after their proper correction the same Brix, which may however not be used for the finding of the sucrose content of juices after Schmitz's tables as these require the uncorrected Brix, *i.e.*, the Brix of the moment of the preparing for the polarisation. In order to come back to the uncorrected Brix as recorded by a hydrometer tested at 17·5° C., we subtract from the corrected Brix the same value, which ought to have been added when the hydrometer had been tested at 17·5° C., thus in our case 0·87. We find for the uncorrected Brix 15·49 − 0·87, and use that value for the finding of the sucrose content by means of Schmitz's table.

5. Polariscope.

Verify every day the polariscope with the tube filled with water and with control quartz plates, which ought to be submitted every four or five years to a technical institute for examination.

Instruments and Utensils Required for the Execution of the Analysis Mentioned in this Treatise.

1. A laboratory three-roller test mill of strong construction.

2. Two dry air baths with double wells, capacity 20 c.dm. (1220·5 cubic inches.)

3. Three extraction apparatuses after Soxhlet for the determination of fibre in cane, made of glass or copper plate, having a sufficient capacity for holding 10 grammes of bagasse or 20 grammes of cane; with three baskets of centrifugal gauze having sufficient capacity to hold ten grammes of bagasse.

4. A refrigerator to condense the alcohol vapours from the above mentioned extracting apparatuses.

5. Eight tared cylinders of copper or tin for the sucrose estimation in bagasse, capacity 1 or $1\frac{1}{2}$ c.dm.

6. Ten tared shallow dishes of tin or copper for the determination of moisture in bagasse, surface 1·5 sq. dm., height 3 cm.

7. Brix hydrometers tested at 17·5° C. provided with a thermometer:—

Five of 0 — 19 degrees Brix.
Six of 10 — 20 ,,
Two of 20 — 30 ,,
Two of 40 — 60 ,,

8. Two Beaumé hydrometers for weighing the lime cream.

9. Three pyknometers with or without thermometer; capacity 50 c.cm.

10. A polariscope with single or double quartz edge compensation, for 400 mm. tubes (half shadow).

11. A control quartz plate $\pm$ 98.
,, ,, $\pm$ 50.

12. Six tubes of 400 mm.
Twelve ,, 200 mm.
Two ,, 100 mm.

13. A lamp for the polariscope, for kerosene oil, acetylene or gas.

14. A good stock of rubber ringlets and cover plates for the observation tubes of the polariscope.

15. An analytical balance, capacity 200 grm., sensitiveness $\frac{1}{5}$ mgr.

16. Balance for weighing the sugar for the polarisation; capacity 500 grammes, sensitiveness 5 mgr.

17. A technical balance; capacity 5 kilos, sensitiveness 100 mgr.

18. A decimal balance, capacity 25 kilos.

19. Weights; for every balance a complete set.

20. Normal weights for the sugar polarisation. 52·096, 26·048 and 13·024 gr.

21. Two dishes of German silver after Scheibler with funnels.

22. A large and a small size dessicator.

23. Twelve copper cylinders with discharge tube for decanting juice samples.

24. Twelve tin cylinders provided with a sieve of wire gauze for collecting juice samples.

25. Measures for lime cream :—

Two of 2 litres
Two of 1 litre
Two of $\frac{1}{2}$ litre.

26. Three copper beakers with spout for the dilution of molasses.
27. Two thermometers of 0 — 200° C.
   ,, ,, 0 — 100° C.
28. Ten glass cylinders for the determination of Brix with the hydrometer.
29. Sixteen cylinders with spout for receiving the filtered, clarified juices to be polarised.
   Ten cylinders without spout.
30. Sixteen glass funnels for filtration of clarified juices, diameter 9 cm.
   Two glass funnels diameter 16 cm.
   ,, ,, ,, 24 cm.
31. Cylindrical measures tested at 17·5° C.
   Two each of 1,000, 500, 250, 50 and 25 c.cm.
32. Ten measure flasks $\frac{100}{110}$.
   Five ,, ,, 100 c.cm. verified at 17·5° C.
33. Two measure flasks verified at 17·5° C. each respectively of 1,000, 500, 250 c.cm.
34. Four burettes of 50 c.cm. divided in $\frac{1}{10}$ c.cm. (17·5° C.).
35. Twelve Erlemeyer ballons for the determination of the glucose.
36. Pipettes verified at 17·5° C.
   Two each of 100 and 50 c.cm., four each of 25, 10 and 5 c.cm. respectively.
37. Fifty test tubes, 20 with 150 mm.
38. Six copper methylated spirit lamps.
39. Two water baths with copper or porcelain rings.
40. A good quantity of filtering paper.
41. A measure of 50 litres.
42. Sharp chopping knives.
43. Stoppered bottles of two litres capacity for collecting samples.

Further, a well-equipped laboratory should possess :—

A set of bottles for test solutions with enamelled label, wood supports for test tubes and pipettes, dropping glasses, washing flasks,

clamps, tweezers, spatulæ and spoons, files, cork borers, cork squeezers, scissors, destruction ballons after Kjehldahl, distillation flasks, spat bulbs, coolers, rubber tubes and stoppers of different sizes, and Kipp's apparatus, washing bottles for gas, beakers, funnels, porcelain basins and crucibles, a Barthel lamp for alcohol, copper wire gauze, asbestos plates with and without aperture, tripods, clay triangles, crucible tongs, test tube holders, glass rods and tubes, mortars, watch glasses with clips, weighing flasks, iron supports with their clamps and rings, filter supports, &c., and a well-assorted stock of chemicals.

Native Assistance.

The exact execution of the analyses and calculations mentioned in the foregoing pages requires the assistance of a well-trained staff of native helpers. Two shifts each consisting of two assistants have proved sufficient for the regular analyses during day and night; one of these men analyses the juices and the other the bagasse, filter press cake, &c. Further, a fifth assistant only working during day time examines the field and factory samples of the cane, the molasses, the fibre contents, &c.

The execution of the analyses and determination in this treatise has been rendered so simple that the European chemist need not occupy himself with them and only exercises a general supervision. An important factor is the strict rule that the juices in which the Brix has been determined and the tubes which have served for the polariscopical test remain untouched for a certain time in order to enable the chemist to verify at any unexpected moment the results entered in the books with his own observation of the same sample, Only the most important determinations, such as polarisation of sugar delivered, &c., need be trusted to the personal care of the European chemist instead of to his assistants.

The Old Market Refinery at Bristol is to be restarted at an early date.

Sugar growing is being encouraged in Zululand, and it is stated that a central factory at Amatikulu to deal with 15,000 tons per season will shortly be erected. The Natal Government is fostering the scheme.

The Honolulu Ironworks appear to be doing a flourishing business amongst the sugar factories of the Hawaiian Islands. Many large orders for new and improved plant, which would once have gone to the U.S.A., are now carried out locally by Mr. Hedemann and his employees.

TWELVE-ROLLER MILLS.

It is not long ago that it was alleged by certain parties that only one or two firms could turn out an efficient nine-roller mill; and now it is announced that a twelve-roller mill has been successfully tried on a Hawaiian plantation, and in consequence the Honolulu Ironworks are constructing another mill of the same type for the Makaweli plantation. The original twelve-roller mill, erected at Waipahu, was capable, it is asserted, of extracting 95·5% of the sucrose, as compared with 93% for the nine-roller mill. These figures doubtless only apply locally, as the determination of the sucrose content of the cane varies at different factories. Mr. Lorentz, the manager, cites a 40,000 ton crop as a basis for the calculation of work done by the nine-roller mill, which at $60 per short ton would give, with 2½% increased extraction, an increased yield of 1000 tons of sugar, costing $60,000, and saving the cost of the additional fuel which the 93% extraction would require. He estimates the cost of changing a nine-roller mill into a twelve-roller one at $30,000. With this sum as capital the annual expenses, including interest and depreciation, would total $8,400, and this deducted from the above gain of $60,000, would leave a net annual profit of $51,600 on the outlay.

It is admitted that perhaps a nine-roller mill could by increased dilution secure the same high extraction; but the cost of the extra fuel required would be almost prohibitive.

The work done at Waipahu last season with the first twelve-roller mill in operation was as follows:—

April, 1904.—Extraction 95·32, 13·67 dilution; 51·2 tons of cane per hour.

May.—Extraction 95·62, 1966 dilution; 52·2 tons per hour.

Last year the nine-roller mill had an average extraction of 93·08, dilution 23·35, and 49 tons of cane per hour.

THE SUGAR INDUSTRY IN NATAL.

The following well written account of the present state of the Natal sugar industry is taken from the *British and South African Export Gazette.*

The sugar industry of Natal is one of those enterprises whose successful development stands to the credit of the intelligence and energy of the colonists. Fostered, as it has been, by a moderate protective tariff and special railway rates, it is a convincing testimony to the wisdom of a policy which, in rendering possible the establishment and success of local industries, creates scope for an increased population, and, at the same time, materially assists in the development

of the country. At present a capital of about £1,150,000 is invested in the industry, and the yearly output averages, at the low prices now prevailing, between £550,000 and £650,000. Since the start of the industry, in 1851, it has probably contributed £11,000,000 sterling to the Colony's wealth.

Although started half a century ago, the Natal sugar industry has only reached its present level of prosperity through hard toil, and notwithstanding impediments and bitter vicissitudes which threatened often its very existence. Among the early difficulties of the planters was the finding of a cane suitable for cultivation. Many kinds were successfully tried, but in the Uba or Juba cane it has at last found a sugar plant which admirably suits the soil and climate of Natal, and also its labour conditions. Other retardations were connected with processes and machinery. Of the former, the diffusion process at one time held the day, but direct crushing is now resorted to pretty generally. As regards processes, as well as machinery, however, the experience of our East Indian and other sugar growing colonies has been advantageously drawn upon, while home engineers have lent their assistance in providing the planters with suitable machinery. Foremost among these should be mentioned the sugar engineering expert, Mr. James Smith, of Glasgow, who designed the plant, built by Messrs. McOnie, Harvey & Co., Glasgow, for the mill recently erected on the Tinley Manor Estate of Messrs. J. L. Hulett & Sons, Limited. As many of our readers are probably aware, this company's sugar and tea estates are the largest and best equipped in Natal, and second to them are the Mount Edgecombe Estates of the Hon. A. Campbell, M.L.A., and Tongaat Sugar Co., the Natal Central Sugar Co., Reynolds Bros., Limited, &c. Modernity and equal efficiency is not characteristic of the equipments of all these estates, and according to expert opinion, up-to-date sugar machinery is now a very pressing want in Natal.

As a specimen of an up-to-date sugar mill equipment, the Tinley Manor Mill, recently erected by Messrs. Hulett & Sons, at a cost of £27,000, may be shortly described. The main building is 200 ft. long, 48 ft. wide, and 30 ft. high. It is built of brick, and its situation on the banks of the Umhlali River affords it an ample supply of very necessary water. The pumping plant is able to deliver up to 60,000 gallons per hour. The factory is lit by electricity throughout, a generating plant being installed. There is a weighbridge lifting up to 40 tons, and houses for employees, &c., are provided. Narrow gauge railway trucks bring the cane from the field, and discharge it into a broad elevator, which feeds the mill. The rollers of the latter, of which there are two pairs, are 26 in. diameter. The crushed cane or megass is raised by the elevator, and passes out of the main building to a hopper at the top of the boiler house. The contents of this hopper are discharged into trucks which run on a tram line to

shoots, whence it is delivered to the furnaces. After its extraction by the rollers, the juice falls into the sulphuring and liming tank, whence it passes to the superheaters, thence to five clarifiers, and finally to three eliminators, this last being a process not yet common in Natal. Treatment in the subsiders and the 3,000 gallons capacity triple-effets follows, when it is forwarded to the vacuum pans, the first being of five tons and the second of eight tons capacity. The last process is undergone when the product is submitted to treatment in the centrifugals for the extraction of moisture. Of these there are six, of Weston pattern. Bagging and transport outwards by the railway trucks is the final stage. The furnaces, which are the special design of Mr. Smith, are 6 ft. × 3 ft. 6 in., and are arched and lined with fire-bricks; the unusually light and thin fire-bars are placed horizontally. The boilers, four in number, are multitubular, and each can easily produce 100 I.H.P. with green megass only. The chimney is 147 ft. high—the highest in the colony. The output averages something like 13 tons of sugar per day, and some 55 coolies are required for working the mill.

For general design and labour-saving arrangements this plant is an easy first in Natal; for, as we have said, the larger part of the machinery equipment, especially of the longer established mills, is very antiquated, and capable of being greatly improved, to the advantage, in quantity and quality, of the output. That of the Tongaat Sugar Company was regarded hitherto as the most up-to-date installation, but must yield pride of place to that above described. This estate, and that of Reynolds Brothers, and a few others, have adopted the green megass furnace; but the Mount Edgecombe equipment is a second-hand plant originally derived from Mauritius, and is decidedly old fashioned. The output is nevertheless equal to 4,000 tons per season, which is the same yield as that of the Tongaat Company, while Reynolds Brothers' output is 3,500 tons. Of the remaining large number of mills, their outputs vary from 150 to 1,000 tons a season. Multitubular boilers are pretty generally used, and the mills are driven by compound gearing, hydraulic attachments to give a steady pressure on the cane being used in some cases. Narrow gauge railways are likewise installed on many plantations, that on the Lower Illovo Sugar Estate having cost £7,936. It is eight miles long, and of 2 ft. gauge, the rolling stock being a 20 N.H.P. 5 ton locomotive, and 40 steel, 12 wooden, and two bogie trucks, without sides. The whole of the mills and other machinery, railways apart, are of British manufacture, being required to be massive and strong to prevent breakdowns, as the strains on the rollers are enormous. The chief defect of the plants, generally speaking, is the absence of up-to-date appliances for extracting the cane juice, while evaporating and vacuum pan plants, and sugar driers and centrifugals leave much to be desired.

An industry of such promise as that of the Natal sugar manufacture, not only in the South African, but the world's market, is naturally worthy of increased attention. The fact that it has already secured a considerable export market, both inland and oversea, is to be set down to its credit. In 1903 its products were placed on the markets of the sister colonies, and Delagoa Bay, Beira, Mombasa, &c., to the value of £320,613, and no mention need be made of its presence on the English market, where it suffers by comparison with the products of old cane sugar producing countries, and from the competition of the cheap beet sugar. This aspect of the export business is one which is of wider than local interest, and how to raise the prospects of the Natal industry with those of other of the cane sugar yielding British Colonies to a more flourishing level should be an imperial concern. As it is the progress the Natal industry has made, amidst unexampled hindrances, while it redounds to the credit of the colonists, should be a spur to further exertions, while to the home industries it affords not the least of the many points of interest which the development of the resources of South Africa brings in its wake.

FIJI.

In an article in the *Times* on "Thirty Years of British Rule in Fiji," the sugar industry established there comes in for mention. The writer, after mentioning the attempts to establish a cotton industry, and the conditions of labour, refers as follows to the sugar interests:—

"The cultivation of sugar cane on a large scale very considerably affected the price of labour, and, as may be seen by the statistics quoted, it soon effaced its weaker rival (cotton). The reason is not very hard to discover. The market for cotton was far away. There were no direct boats, and it had to be shipped to England *viâ* the Australasian colonies. That meant double freight, commission, and double charges of all sorts. On the other hand, there was a large and immediate demand for sugar in Australia and New Zealand. So, in spite of all vicissitudes, and the competition of beet sugar, aided by the foreign bounties and the consequent enormous drop in prices, the production of Fijian sugar has steadily advanced. One has only to consult the prices obtained in 1880 and in 1900 to understand how successful it has been, and how well it has stood the strain. In the first-mentioned year the average price obtained was slightly over £40 a ton and in the latter slightly under £11 10s. The labour, too, for the cultivation of cane costs double what it did in the old cotton days. Notwithstanding all this, sugar is the main industry of Fiji, and it is steadily and surely going ahead. This success has been achieved by the employment of large capital, scientific cultivation and manufacture, and by a trustworthy supply of labour. This last

is furnished by a steady importation of Indian immigrants every year. They are introduced under the ordinary indenture system prevalent in the West Indies and other tropical colonies. The wages of these as field hands are 1s. a day. To this has to be added the cost of introduction and return home at the expiration of ten years, of housing, medical care, and other incidentals, which all mount up, so that it is usual in forming estimates to calculate the price of labour at 2s. a day. As the demand for labour on the sugar estates is greater than the supply, the rates prevailing there rule the market, and it may be now safely averred that all classes of coloured labour, whether Fijian, Polynesian, or Indian, cost not less than 2s. a day."

PROGRESS REPORT ON THE USE OF NATIVE SUGARS FOR PRESERVES.

BY H. H. COUSINS, M.A., F.C.S.

This subject was considered to be of importance to the sugar industry of Jamaica, and the Sugar Department is engaged on an investigation of the matter. The following results have been already obtained:—

Samples of Sugars.

Brown and White Vacuum Pan Sugars were obtained from merchants and sugar planters, as follows:—

Sugars.

Estate.	Description.	Polarisation. Per cent.
Belleisle	White	98·9
Do.	Brown	98·2
Caymanas	White	99·0
Do.	'Yellow Demerara'	96·9
Per Messrs. Myers	White	98·6
Per Messrs. Wray & Nephew	Brown ..	96·1
Cinnamon Hill	Brown	98·6
Do.	Fair..	99·8
Serge Island	Brown	98·4
Worthy Park	Brown	99·3

These data are very creditable to our Jamaica sugars. The sugars from Cinnamon Hill and Worthy Park were of unusual purity and nearly chemical sucrose. Some of the other sugars were somewhat damp and moist. We have, regularly produced in the island, a supply of sugars well fitted for preserving if properly sterilised. We found, however, that all these sugars were more or less infected with a species of *Torula* with a powerful fermentive action. All these sugars rapidly developed this organism when introduced into sterile nutritive media, even in the proportion of equal parts sugar and

medium. This shows that unless perfectly sterilised, the native sugars could not successfully be used for preserving in the usual proportion of half sugar to half fruit.

Experiments in Sterilisation and with Preservatives.

Neither *Boric Acid* nor *Formaldehyde*, within the limits at all permissible in a food product, were effective in preserving fruit pulp. *Sulphur Dioxide*, however, proved strikingly effective, and it was decided to select this preservative as the best and least harmful agent for preserving fruit pulp and jams.

Provided sterile conditions could be maintained in the containing vessel, steaming proved completely effective in preserving both pulps and jams made with native sugar.

It was found, however, under commercial conditions of packing, that marmalades made with native sugars fermented. By adding half per cent. *Calcium Bisulphite* solution of specific gravity 1·068 all marmalades made with Jamaica sugars have kept perfectly. The preservative is harmless and was not found to affect the flavour of the marmalade.

Mango Jams.

A number of mango jams made with the native sugars before and after treatment with sulphur fumes, have kept to date—6 weeks. No difference can yet be seen between the treated and untreated jams. A longer trial is necessary before any conclusion can be drawn.

Pine Slices in Syrup.

A trade to the United States in cut slices of pine packed in barrels in a secret preservative liquid (? salicylic acid) flourished for a while, but has, I understand, been destroyed by the prohibition of the preservative by the United States Government. Our experiments indicated that a half per cent. solution of Calcium Bisulphite was an efficient preservative for raw sliced pines with or without native sugar in the form of syrup. It is hoped that this trade may be resuscitated, as bisulphite could not be prohibited as dangerous to health.

Conclusions.

1. Our best native sugars are of high quality, but are all infected with the fermentive *Torula* and special treatment is required to ensure a sterile preserve.

2. *Sulphur Dioxide* and *Calcium Bisulphite* appear to be the best chemical preservatives for fruit pulp, fruits in syrups and jams made with the native sugars.

I am importing a supply of bisulphite with a view to preparing some small commercial samples for shipment to England and America.—*(Bulletin of Dept. of Agr. Jamaica.)*

RECENT EXPERIMENTS WITH SALINE IRRIGATION.

C. F. Eckhart.

In the annual report of the Experiment Station for 1902, considerable space was devoted to results obtained from irrigating sugar cane with water containing 200 grains of salt per gallon. The investigations discussed at that time comprised small lysimeter experiments and dealt with the solvent action exerted on the soil elements by saline water, and the toxic effect of various salts on the growth of cane.

It was found that when occasional excessive irrigations were applied to cane growing in tubs (constructed so as to allow of free drainage), the use of irrigation water of high salt content only checked in small measure the growth of the cane. It was also shown that large quantities of lime were liberated from the lysimeter soils through displacement by the sodium in the irrigation water, and it was indicated that the lime chloride so formed had a smaller toxic effect on the cane than a like amount of sodium chloride in the soil water. The data contained in this report are the results of investigations pursued in the field, where the information gained from the lysimeter tests was applied on a larger scale for confirmation of results.

Nine plats, each 1500 square feet in area, were laid off in the Experiment Station field, planted with Lahaina cane, and treated as follows:—

Plat No. 1.—Fresh water applied in irrigation. Fertilisation was at the rate of 100 lbs. of nitrogen (1-3 organic, 1-3 from nitrate of soda, 1-3 from sulphate of ammonia), 200 lbs. of potash as sulphate of potash, and 50 lbs of phosphoric acid as double superphosphate, per acre.

Plat No. 2.—Irrigation was the same in quantity as in Plat No. 1, but contained 200 grains of salt per gallon. Two tons of lime in the form of ground coral were added to the plat after the cane was a foot high, and partially incorporated with a superficial layer of the soil. Mixed fertilizer applied as in Plat No. 1.

Plat No. 3.—Irrigation and mixed fertilizer applied as in Plat No. 2. Instead of ground coral, 2 tons of lime in the form of gypsum were mixed with the soil.

Plat No. 4.—Irrigation and mixed fertilizer, the same as in No. 2. No lime added.

Plat No. 5.—Same irrigation as in Plat No. 2. Mixed fertilizer at the rate of 100 lbs. nitrogen as nitrate of soda, 200 lbs. potash as sulphate of potash, and 50 lbs phosphoric acid as double superphosphate, per acre.

Plat No. 6.—Same irrigation as in Plat No. 2. Mixed fertiliser at the rate of 100 lbs. nitrogen as sulphate of ammonia, 200 lbs. potash

as sulphate of potash, and 50 lbs. phosphoric acid as double superphosphate, per acre.

Plat No. 7.—Same irrigation as in Plat No. 2. Mixed fertilizer at the rate of 100 lbs. nitrogen as dried blood, 200 lbs potash as sulphate of potash, and 50 lbs. phosphoric acid as double superphosphate, per acre.

Plat No. 8.—Irrigated with fresh water, a heavy irrigation being applied every eighth watering. Mixed fertilizer applied at the rate of 100 lbs. nitrogen as sulphate of ammonia, 200 lbs. potash as sulphate of potash, and 50 lbs. phosphoric acid as double superphosphate, per acre.

Plat No. 9.—Irrigated with same quantities of water as Plat No. 8, water containing 200 grains salt per gallon. Fertilization the same as in Plat No. 8.

IRRIGATION OF SALT WATER EXPERIMENTS. (INCHES.)

Month.	Rainfall.	Irrigation Plats 1—7.	Irrigation Plats 8 and 9.
June, 1902	·96	2·0	2·0
July	2·21	5·0	5·0
August	1·46	4·0	8·0
September	2·19	4·0	4·0
October	2·25	5·0	9·0
November	8·35	2·0	2·0
December	8·12	1·0	1·0
January, 1903	3·28	2·0	6·0
February	4·32	1·0	1·0
March	·68	5·0	5·0
April	2·11	3·0	7·0
May	2·05	4·5	4·5
June	·83	7·5	11·0
July	1·67	8·0	8·0
August	2·20	8·0	11·0
September	4·98	8·0	8·0
October	1·75	6·0	8·0
November	2·24	5·0	5·0
December	1·30	..	..
January, 1904	4·88	..	..
February	24·10	..	..
March	6·04	..	..
April	2·11	..	..
	90·08	81·0	105·5

Plats Nos. 1 to 7 inclusive received the same volume of irrigation water, 2 inches being the maximum amount applied at one time. Plats Nos. 8 and 9 received ordinarily the same irrigation as the

other plats, but for every eighth watering this was increased to 5 inches. The dates on which Plats 8 and 9 received a 5-inch irrigation were: August 6th and October 2nd, 1902, and January 20th, April 21st, June 17th, August 5th, and October 21st, 1903.

The volume of rainfall and irrigation received, together with amounts of salt applied per acre, are next given:—

Plat.	Rainfall Gallons.	Irrigation Gallons.	Salt per Gal. Grains.	Salt Applied per Acre. Lbs.
1	2,446,032	2,199,474	....	....
2—7	2,446,032	2,199,474	200	62,842
8	2,446,032	2,864,747	....	....
9	2,446,032	2,864,747	200	81,850

Plats Nos. 1 to 4 constitute the lime tests. It is to be regretted that limited field space would not permit the carrying out of experiments in which fresh water and gypsum, and fresh water and ground coral were applied for comparison of results so obtained, with results from Plats Nos. 2 and 3 receiving ground coral and gypsum respectively, but irrigated with salt water. We would then know more exactly the percentage of gain in sugar yields which could be attributed to the ordinary agricultural value of the lime applications, and also the gain due to the neutralisation of the salt carried into the land with the irrigation water. It is quite safe to assume, however, that owing to the nature of the station soil it would not show any appreciable gain from treatment with gypsum and ground coral where fresh water is used in irrigation. The lime in this soil is unusually high, showing by absolute analysis 1·01 per cent.; by the agricultural method, ·861 per cent.; and by the aspartic acid method, ·325 per cent. The gypsum through its indirect action would liberate considerable quantities of potash, which would allow the presence of so much more available potash in Plat No. 3; the heavy potash fertilisation of these plats, 200 lbs. per acre, however, together with the amount made available by the salt, would minimise the effect of potash liberated by the gypsum. This latter point is clearly brought out by the yields of sugar from Plats Nos. 2 and 3, which are almost identical.

The quality of the juice and the quantity of cane and sugar produced per acre in the first four experiments are shown in the following tables:—

QUALITY OF JUICE.

Plat	Salt per Gal. of Water Irrigation.	Form of Lime Added.	Brix of Juice.	Sucrose of Juice.	Glucose of Juice.	Purity of Juice.	Gums of Juice.	Chlorine per Gal. of Juice.	Salt per Gal. of Juice.
1	None.	No lime	20·28	18·90	·312	93·20	·43	9·8	16·17
2	200 grains	G. coral	16·46	14·40	·264	87·50	·53	93·1	153·63
3	200 grains	Gypsum	16·56	14·50	·271	87·60	·56	84·94	140·17
4	200 grains	No lime	15·89	13·80	·280	86·8	·50	105·24	173·67

Cane and Sugar per Acre.

Plat	Salt per Gal. of Water.	Form of Lime added.	Cane per Acre, lbs.	Sucrose in Cane per cent.	Sugar per Acre, lbs.	Percentage gain through use of Lime.
1	None	No lime	151,675	16·91	25,648	....
2	200 grains	Ground coral	42,311	12·88	5,449	46·6
3	200 grains	Gypsum	42,108	12·97	5,461	46·9
4	200 grains	No lime	30,085	12·35	3,715	

The most striking point in regard to these results is the great difference in sugar yields displayed between the plat receiving fresh water and the plats receiving irrigation containing 200 grains of salt per gallon. The difference in the amounts of sugar produced, approximated 11 tons, and this was caused by the application of no salt in the one instance and practically 31 tons per acre in the other.

The juice of the cane receiving saline irrigation was characterised by lower density, less sucrose and glucose, a lower purity, and a much larger content of salt, than the juice of the cane receiving fresh water. Where lime in the form of ground coral and gypsum was applied a better showing was made in regard to density, sucrose, glucose, purity, and salt content, than where no lime was added. The percentage of gain in the former instance was a trifle higher than in the latter.

The gain in the sugar of the cane where ground coral was applied was 46·6 per cent., and with gypsum 46·9 per cent., compared with the plat that was not limed. The difference in the amounts of available sugar would be somewhat higher than these figures owing to the difference in the purity and salt content of the juices.

The influence of the form of nitrogen, applied in mixed fertilizers, on the yield of sugar in salt water plats may be seen from the following figures:—

Quality of Juice.

Plat.	Form of Nitrogen in Mixed Fertilizer.	Salt in Irrigat'n, Grs. per Gallon.	Brix. of Juice.	Suc. of Juice.	Gluc. of Juice.	Purity of Juice.	Gums of Juice.	Chlorine of Juice. Grs. per Gallon.	Salt of Juice. Grs. per Gallon.
4	3 forms of Nit.	200	15·89	13·80	280	86·8	·50	105·24	173·67
5	Nit. of Soda ..	200	16·86	14·70	·286	87·2	·53	66·04	108·98
6	Sul. of Am. ..	200	16·80	14·90	·297	88·7	·62	67·67	111·62
7	Blood	200	16·96	15·2	·328	89·6	·63	86·10	142·08

Cane and Sugar per Acre.

Plat.	Form of Nitrogen in Mixed Fertilizer.	Salt in Irrigation. Grs. per gal.	Cane per Acre. lbs.	Sucrose in Cane. Per cent.	Sugar per acre. lbs.
4	3 forms of Nitrogen ..	200	30,085	12·35	3,715
5	Nitrate of Soda..	200	35,515	13·15	4,670
6	Sulphate of Ammonia..	200	31,218	13·13	4,161
7	Blood..	200	57,963	13·6	7,882

The largest production of sugar was obtained where the entire amount of nitrogen was applied in the form of dried blood. While a small gain was to be expected, owing to the salt water having but little effect on nitrification (see report for 1902, page 61), from the use of dried blood for Lahaina cane under Experiment Station conditions, we were surprised at the large difference in yields. The yields of sugar from Lahaina cane harvested at the same time, and which received the same fertilization, but to which fresh water was applied in irrigation were as follows:—

Form of Nitrogen in Mixed Fertilization.	Sugar per acre. lbs.
Dried blood..	22,254
Nitrate of Soda	21,262
Sulphate of Ammonia	19,262

The order of yields in the salt water plats was the same as the above, although the percentage of gain from dried blood was greater. The more vigorous cane produced by fertilization with dried blood, withstood the deleterious action of the salt in a more pronounced manner than the cane in the other plats.

Effect of Occasional Heavy Irrigation on Yields of Salt Water Plats.

It was shown in the report for 1902, that when cane was grown in tubs, allowing a perfect drainage, an occasional heavy irrigation, by leaching accumulations of salt from the soil, permitted an almost normal growth In the field this perfect drainage cannot be obtained, but a heavy irrigation, now and then, is capable of reducing the salt content of the soil to such an extent that the cane is checked in less measure than where the salt is allowed to accumulate in larger quantities.

This is fully shown by the following figures:—

Quality of Juice.

Plat.	Irrigation.	Salt in Irrigation per gallon Grs.	Brix of Juice.	Sucrose in Juice.	Gluc of Juice.	Purity of Juice.	Gums of Juice.	Chlorine of Juice grs. per gallon.	Salt of Juice grs. per gallon.
6	Normal	200	16·80	14·90	·297	88·7	·62	67·67	111·62
8	Excess	—	20·02	18·7	·288	93·4	·54	8·63	14·24
9	Excess	200	16·08	14·0	·272	87·1	·30	109·44	180·6

Cane and Sugar per Acre.

Plat.	Irrigation.	Salt in Irrigation, per gallon. grs.	Cane per Acre. lbs.	Sucrose in Cane. Per cent.	Sugar per Acre. lbs.	Per cent. gain over No. 6.
6	Normal ..	200 ..	31,218 ..	13·33 ..	4,161 ..	—
8	Excess ..	— ..	182,981 ..	16·73 ..	30,612 ..	—
9	Excess ..	200 ..	62,494 ..	12·53 ..	7,830 ..	88·1

The cane on these plats was grown under the same conditions except with regard to irrigation. Plat No. 6 received a normal volume of water weekly, while Nos. 8 and 9 received an occasional heavy watering (five inches every eighth irrigation). Plats Nos. 6 and 9 received water containing 200 grains of salt per gallon, and No. 8 received fresh water.

The extra irrigation water applied to Plats Nos. 8 and 9 amounted to 24·5 inches. This quantity when fresh increased the amount of sugar by 4,964 lbs. or 19·3 per cent.; where salt water was used the gain was 3,669 lbs. of sugar or 88·1 per cent. If a gain in Plat No. 9 were entirely due to an increased growth resulting from a larger available supply of water in the soil, we would expect the percentage of gain in yield to be somewhat proportional to that in Plat No. 8; this would allow the production of 4,964 lbs. of sugar. The difference between the yield of Plat No. 9, 7,830 lbs., and 4,964 lbs. would represent approximately the gain from the leaching effect of the extra irrigation applied. The difference amounts to 2,864 lbs. of sugar or 68·8 per cent. The investigations of 1902 and those recently completed in the field justify the following conclusions.

Conclusions.

Lime is a potent agent in modifying the deleterious effect of saline irrigation on the growth of cane. On the experiment station field, application of lime in the forms of ground coral and gypsum and at the rate of two tons of lime per acre resulted in a gain of sugar amounting to 46 per cent.; the irrigation water containing 200 grains of salt per gallon.

Occasional heavy irrigations given to a moderately porous soil receiving brackish irrigation, is most effective in reducing the salt content of the soil to a less toxic quantity. A gain of 88·1 per cent. of sugar was obtained in the Experiment Station field by a five inch irrigation every eighth watering; at least 77 per cent. of this gain may be attributed to the leaching of salt accumulations from the soil.

August 8th, 1904.

The St. Lucia Usines & Estates Company are reported to have placed an order with the Mirrlees Watson Co., Ltd., Glasgow, for a powerful grinding plant for their Roseau Factory.

Austria-Hungary.

Fiume.—The sugar sent to the United Kingdom in 1903 consisted of 70,000 tons raw, 47,000 tons powder and crystallised and 3,000 tons refined. The second item would usually have been shipped to India, but was diverted to the United Kingdom as already explained.

This is about the surplus of the sugar production of Hungary to be reckoned with as available for export under ordinary circumstances in future, viz., 60,000 to 70,000 tons to the United Kingdom and 40,000 to 50,000 tons to India.

Germany.

Hamburg.—The year 1903 did not fulfil the rather sanguine expectations of the German sugar trade. In consequence of the uncertainty existing at first concerning the actual conclusion of the Brussels Sugar Convention, and subsequently concerning its effects upon the sugar industry and trade, the market was placed in a difficult position, not knowing how to act in regard to the future. It had, it is true, been expected that the transition period would be fraught with difficulties; but eventually these were found to be more serious even than had been apprehended. For a time all export trade was entirely put an end to, and inland prices consequently declined considerably. It was only after a modification had taken place (thanks to the authorities here and in other countries) in the numerous formalities required at first for all sugar exported after August 31st last, that increasing shipments began to be made, and towards the end of last year the sugar export trade here had almost recovered its normal condition. Now that Hamburg exporters are are accordingly beginning to feel that the transition period has been almost overcome, it is expected that German sugar will certainly soon resume the important position it used to occupy. The decrease, which may perhaps later take place in the export trade from this and other German ports, will no doubt be speedily filled up by an augmentation of German inland consumption of sugar in consequence of its largely reduced price. In so far as the interests of the German sugar industry are concerned, these, it is thought here, would at the same time be best served by a prudent limitation of beetroot cultivation to a much more restricted area than at present. The total quantities of sugar exported from Hamburg to all parts of the world during each of the last three years were as follows:—In 1903, 10,693,600 bags; in 1902, 10,627,100 bags, and in 1901, 10,172,300 bags. The stock remaining on hand at the end of 1903 was 2,481,700 bags, as against 1,025,300 in the preceding year.

Spain.

Adra.—The production of sugar is increasing, and reached last year 2,000 tons, with an average price of 110 pesetas the 100 kilos. The

laying down of a powerful irrigation plant will contribute to the increase of the plantations.

Marbella.—The colony of San Pedro Alcantara produces sugar, and the yields during the years 1902-03 have been as follows:—

Year.	Quantity. Cwts.
1902	13,805
1903	15,784

Although no sugar has been obtained from beetroot this colony shows an increase of 1,979 cwts. over the previous year.

At El Angel the yield of sugar cane, compared with the 1902 crop, is as follows:—

Year.	Quantity. Cwts.
1902	6,204
1903	6,555

China.

Ningpo.—Imports of foreign sugars show a considerable falling off during 1903, amounting in all to 155,800 cwts. The figures for 1902 and 1903 are as follows:—

	1902.		1903.	
	Cwts.	£.	Cwts.	£.
Brown sugar	233,381	89,197	160,618	69,335
White ,,	42,628	23,274	24,526	14,388
Refined ,,	251,303	137,167	186,280	123,712

Japan.

Yokohama.—A prominent feature in the local sugar trade for 1903 was the almost complete shutting out of the produce of the Hong-Kong refineries, which were not able to compete against Continental beets and the out-turn of the Japanese refineries, the latter being favoured by the refund of import duties on conversion of their imports of raw sugar, which, as against Hong-Kong manufacture, gave them an advantage of 1s. 8¼d. per picul (138 lbs.).

The import of beet sugar showed a considerable increase on that of 1902, German produce falling back but Austro-Hungarian taking a more prominent place by reason of comparative cheapness in price.

An increased trade was also done in brown sugars, more especially in Javas and Philippines, the former being imported largely for refining purposes.

Morocco.

The sugar trade in South Morocco (now almost all in French hands) is always a very big one. It is regrettable that the United Kingdom does not attempt to participate in it in any way. It would be worth the while of dealers to make enquiries about it. In 1903 59,840 cwts. of sugar of the value of £49,350 were imported.

Zanzibar.

Granulated beet sugar, which is packed in double gunny bags, comes to Zanzibar in large quantities from Hamburg, and cane sugar

is also supplied by India. In 1903 the amount imported was valued at £18,845.

Mexico.

Vera Cruz.—The British Consul in his report for 1903, says:—There are over 1,200 sugar mills in Mexico, of which 300 may be considered as really important producers, and cane growing and sugar refining are becoming of considerable consequence. The mills, equipped with British or American machinery, are general and the number is increasing.

The State of Vera Cruz is the second largest producer of cane, being surpassed only by Morelos. The present year will probably show the greatest crop hitherto gathered, and the next few years may see a surprising development of the industry. At the same time for the small producer there is, I fear, a bad time coming, and many of the old fashioned and less important mills must soon go to the wall.

The sugar exported, about 20,000 tons annually, now goes almost entirely to the United Kingdom, and the reduction of the duty on imported sugar, which came into effect on May 1, 1904, aims solely at securing for Mexican exported sugar the privileges of the Brussels Convention.

Common and refined sugar of all kinds, including the so-called sugar-candy, formerly paid per gross kilo. 15 c. Mexican currency, while the new rate is 2 dol. 50 c. per 100 kilos. gross.

The totals produced during the last few years were during 1900, 78,000 tons; 1901, 95,000 tons; 1902, 103,000 tons; 1903, 112,000 tons, and the 1904 crop is estimated at 126,000 tons.

Molasses from sugar cane or fecula, as well as preparations for colouring wines, liquors, &c., and for grading up sugar, have hitherto paid duty per gross kilo. 5 c., while the new rate is 2 dols. 25 c. per 100 kilos. gross. The total product of molasses in 1903 was 77,000 tons.

During 1903, owing to the manipulation of speculators, the price of sugar was maintained for a while, but the syndicate which undertook to sustain the local market in spite of the elaborate arrangements for regulating and restricting the supply, failed dismally.

Porto Rico.

The British Consul reports:—The area of sugar cane cultivation is increasing, but not so rapidly as Porto Rico's favourable position with regard to the certain and free United States market over other sugar-producing areas would seem to justify, even in view of the possibilities of the United States reciprocity with Cuba.

The crop for 1903, as estimated in my last report, was almost accurately realised, viz., 105,000 tons, and these figures it is thought will be exceeded by some 20 per cent. this year.

The crops for the last three years are as follows:—

Year.	Quantity. Sugar. Lbs.	Molasses. Gallons.
1900-01	137,817,470 ...	2,848,314
1901-02	183,822,636	3,080,132
1902-03	233,070,000	3,537,000

UNITED STATES.

San Francisco.—There are 48,150 acres under beet in California, and the total beet sugar output for the 1902 season was 73,761 short tons, having doubled during the last three years. The production for 1903 is estimated about 77,000 short tons. California now holds the first place in the United States in beet sugar production, with Michigan second with 54,753 short tons, and Colorado third with 38,777 tons. There are eight factories with a combined daily capacity of 11,800 tons of beets.

In the importation of sugar into the United States during the past fiscal year beet sugar only amounted to 87,000,000 lbs., as against 255,000,000 lbs. for 1901-02 and 908,000,000 lbs. in the previous year. Of the sugar received in 1902-03 upwards of 226,000,000 lbs. came from Porto Rico, and nearly 775,000,000 lbs. from Hawaii. A very large quantity of Hawaiian cane sugar is refined in the Californian mills.

New Orleans.—During the year 1903 some 323,000 tons of sugar of foreign and native origin combined were dealt with at New Orleans. Of this quantity 80 per cent. found its way to the sugar refineries, and 20 per cent. went direct into consumption. This is a fair representation of the average trade in sugar at New Orleans, and the port maintains its usual place of importance in respect to the total sugar trade of the United States. The average price realised was above that of the preceding year, due in part to the delay in negotiating the Reciprocity Treaty with Cuba. That treaty came into effect on December 27, 1903, since which date prices have dropped both in the foreign and home produce, until all advantage has been lost.

Oregon.—Oregon gives no bounty on the production of beet sugar, but Washington and Idaho grant a bounty of ½d. per lb.

The following statistics of production are furnished by the owners of the factories:—

Factories.	1903.			1902.	1901.	1900.
	Area Planted.	Beets Harvested.	Sugar Produced.			
	Acres.	Tons.	Lbs.	Lbs.	Lbs.	Lbs.
La Grande, Oregon	2,800	12,021	2,807,700	4,535,300	3,214,000	1,989,000
Waverley, Washington....	3,500	23,000	5,400,000	3,676,600	2,640,000	1,132,506
Sugar City, Idaho	3,500	31,392	7,400,000	..	..	..
Total..	9,800	66,413	15,607,700	8,211,900	5,864,000	3,121,506

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. Thompson, C.E., F.C.S., M.I.M.E., Chartered Patent Agent, 6, Lord Street, Liverpool ; and 322, High Holborn, London.

ENGLISH.—Abridgments.

16750. G. Harrison. (Communicated by the firm of F. Hlavati & Co., of Genoa, Italy.) *An improved manufacture of sugar.* 30th July, 1903. According to this invention the main purification of the liquid containing sugar takes place during the diffusion. For this purpose, there is added to the cut-up vegetable material containing sugar, such for example as the pieces of sugar-beet or the like, during the filling of the diffusion apparatus, or to the diffusion-water, such substances as dissolve and combine with the organic non-sugar substances dissolved from the cut-up pieces of vegetable material so as to form difficultly-soluble or insoluble substances, such for example as gypsum, peroxides of the alkaline-earth metals, permanganates of the alkaline-earth metals, a mixture of a hydroxide of an alkaline-earth metal with peroxide of manganese or with peroxide of hydrogen, &c.

20777. J. McNeill & C. McNeill, Govan, Lanark, N.B. *Improvements in evaporating or concentrating apparatus.* 28th Sept., 1903. This invention relates to an evaporating or concentrating apparatus, a rotatable hollow shaft, carried in stuffing boxes provided with a steam inlet and a water outlet, and internally partitioned into steam and water spaces, and a series of tubular heating surfaces, the interiors of which communicate with the steam and water spaces.

21485. J. J. Marshall, Leeds, York. *Improvements in the method of and apparatus for weighing granulated sugar and the like.* 6th Oct., 1903. This invention relates to a machine for weighing sugar or like material, in which the feed is automatically controlled by means of a reducing slide and a cut-off slide, the combination of an equal-armed main scale beam (or beams), an adjustably weighted auxiliary scale beam, means by which the said main scale beam is suspended from the auxiliary scale beam, and means by which the said slides are successively actuated, the reducing slide being actuated from the upper or auxiliary scale beam and the cut-off slide being actuated from the lower or main scale beam.

12527. R. von S. de Tornya, Budapest, Hungary. *Improved manufacture of molasses food for animals.* 2nd June, 1904. This invention relates to the manufacture of molasses flour consisting in drying moist molasses food in drying kilns, or in any other drying apparatus, at a temperature of about 45° C. for say from 72 to 96 hours, and finally grinding the dried product.

GERMAN.—ABRIDGMENTS.

152269. W. WEHRSPANN, of Rethen-on-Leine. *An arrangement for sharply separating the drain in centrifugals for sugar and the like.* 1st May, 1903. The sharp separation of the drain is effected by means of revoluble vertical arms on the inner side of the centrifugal casing, provided at the edges with packing in such a way that each two of these arms in their end position only uncover or close drain apertures in the bottom of the centrifugal leading to one of two collecting gutters. In their adjustment the arms slide in recesses in the bottom, so that the bottom surface is cleaned by the lower edge of the arms. For the same object if desired the lower face of the cover of the centrifugal is scraped by the upper edges of the arms.

152675. MARCHEVILLE-DAGUIN & CIE, of Paris. *A machine for centrifuging and casing sugar and the like in a conical drum, the discharge aperture of which has a smaller diameter than its bottom.* 24th March, 1903. The drum is conical in form, and the bottom is formed of the larger face whilst the end is perfectly open. This end has also no inner edge as in the ordinary devices, so that the use of a scraper is possible, which, in order to discharge the drum, only requires to make a movement to and fro in a straight line, and can pass completely out of the drum. The material treated is retained in the drum by reason of its conical shape in spite of the absence of the inner edge.

152904. WILHELM BENEMANN, of Neu-Schönsee, near Schönsee, West Prussia. *A method of rapidly de-sugaring sugar drain, and producing cattle food.* 8th March, 1903. The process consists in adding to the drain before, during, or after the boiling down to the degree of concentration necessary for the other operations, a substance suitable for cattle food, such as rice meal, meat powder, ground nut meal, &c., which in the subsequent centrifuging of the crystal sugar remains in the sugar.

IMPORTS AND EXPORTS OF SUGAR (UNITED KINGDOM

To end of August, 1903 and 1904.

IMPORTS.

Raw Sugars.	Quantities.		Values.	
	1903.	1904.	1903.	1904.
	Cwts.	Cwts.	£	£
Germany	3,018,051	4,524,776	1,245,633	2,030,563
Holland	162,407	184,273	61,980	88,658
Belgium	619,912	282,453	258,269	126,025
France	476,985	268,227	209,457	134,226
Austria-Hungary	1,483,228	683,106	621,907	307,428
Java	211,900	1,401,544	100,472	618,432
Philippine Islands	70,646	86,650	25,285	31,025
Cuba	422,605	....	209,722	....
Peru	199,549	703,004	78,780	324,567
Brazil	67,076	82,317	26,185	31,176
Argentine Republic	409,947	....	184,810	....
Mauritius	264,040	378,275	94,226	139,781
British East Indies	229,602	186,986	83,354	75,501
Br. W. Indies, Guiana, &c.	522,807	809,929	319,731	523,700
Other Countries	419,830	410,395	182,901	189,489
Total Raw Sugars	8,578,585	10,001,935	3,702,712	4,620,571
Refined Sugars.				
Germany	10,730,678	7,675,077	5,583,838	4,328,819
Holland	1,533,069	2,167,169	884,641	1,289,119
Belgium	95,163	315,328	55,745	180,722
France	611,498	1,689,593	347,418	937,102
Other Countries	830,320	168,866	409,477	89,421
Total Refined Sugars	13,800,728	12,016,033	7,281,119	6,825,183
Molasses	1,023,010	1,119,142	186,736	210,270
Total Imports	23,402,323	23,137,110	11,170,567	11,656,024

EXPORTS.

British Refined Sugars.	Cwts.	Cwts.	£	£
Sweden and Norway	17,327	21,277	8,976	11,031
Denmark	67,789	80,065	36,856	40,489
Holland	42,324	40,899	22,865	21,581
Belgium	5,205	7,520	2,618	4,025
Portugal, Azores, &c.	5,611	10,439	3,064	5,559
Italy	6,622	2,888	3,028	1,341
Other Countries	483,341	230,126	292,548	146,659
	628,219	393,214	369,965	230,685
Foreign & Colonial Sugars.				
Refined and Candy	31,884	18,032	19,267	12,381
Unrefined	42,663	76,613	22,184	42,681
Molasses	1,270	1,657	669	930
Total Exports	704,036	489,516	412,085	286,677

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1904. Tons.		1903. Tons.
Total Receipts, Jan. 1st to Sept. 15th ..	1,404,853	..	1,281,911
Receipts of Refined ,, ,, ,, ..	414	..	1,197
Deliveries ,, ,, ,, ..	1,405,586	..	1,233,744
Consumption (4 Ports, Exports deducted) since 1st January	1,316,962	..	1,226,108
Importers' Stocks (4 Ports) Sept. 14th ..	11,428	..	50,552
Total Stocks, Sept. 28th.	167,000	..	172,665
Stocks in Cuba, Sept. ,, ...	12,000	..	156,000
	1903.		1902.
Total Consumption for twelve months ..	2,549,643	..	2,566,108

CUBA.

STATEMENT OF EXPORTS AND STOCKS OF SUGAR, 1903 AND 1904.

(Tons of 2,240lbs.)	1903. Tons.		1904. Tons.
Exports	772,281	..	1,042,177
Stocks	203,683	..	47,558
	975,964	..	1,089,735
Local Consumption (eight months)	26,045	..	27,860
	1,002,009	..	1,117,595
Stock on 1st January (old crop)	42,530	..	94,835
Receipts at Ports up to August 31st....	959,479	..	1,022,760

Havana, 31st August, 1904. J. GUMA.—F. MEJER.

UNITED KINGDOM.

STATEMENT OF IMPORTS, EXPORTS, AND CONSUMPTION FOR EIGHT MONTHS ENDING AUGUST 31ST.

SUGAR.	Imports. 1902. Tons.	Imports. 1903. Tons.	Imports. 1904. Tons.	Exports (Foreign). 1902. Tons.	Exports (Foreign). 1903. Tons.	Exports (Foreign). 1904. Tons.
Refined	673,079	690,038	600,802	1,775	1,594	902
Raw	477,489	428,929	500,097	2,894	2,133	3,831
Molasses	46,160	51,150	55,957	64	63	82
Total.........	1,196,728	1,170,115	1,156,856	4,733	3,790	4,815

	Home Consumption. 1902. Tons.		Home Consumption. 1903. Tons.		Home Consumption. 1904. Tons.
Refined..	669,096	..	634,025	..	610,936
Refined (in Bond) in the United Kingdom	—	..	—	..	343,200
Raw	447,108	..	387,679	.	86,988
Molasses	42,691	..	41,281	..	53,270
Molasses, manufactured (in Bond) in U.K.	—	..	—	..	39,460
Total	1,158,895	..	1,062,985	..	1,133,854
Less Exports of British Refined....................	20,586	..	31,411	..	19,661
Total Home Consumption of Sugar	1,138,309	..	1,031,574	..	1,114,193

Stocks of Sugar in Europe at uneven dates, Sept. 1st to 28th, compared with previous Years.

In thousands of tons, to the nearest thousand.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	Total 1904.
86	286	433	137	86	1028

	1903.	1902.	1901.	1900.
Totals	1429 ..	1408 ..	555 ..	408

Twelve Months' Consumption of Sugar in Europe for Three Years, ending August 30th, in thousands of tons.

Great Britain.	Germany	France.	Austria.	Holland, Belgium, &c.	Total 1903-4.	Total 1902-3.	Total. 1901-2.
1550	1126	699	509	560	4414	3761	4109

Estimated Crop of Beetroot Sugar on the Continent of Europe for the current Campaign, compared with the actual crop of the three previous Campaigns.

(From Licht's Monthly Circular.)

	1903-1904. Tons.	1902-1903. Tons.	1901-1902. Tons.	1900-1901. Tons.
Germany	1,933,435 ..	1,762,461 ..	2,304,923 ..	1,984,187
Austria	1,177,210 ..	1,057,692 ..	1,301,549 ..	1,094,043
France	804,401 ..	833,210 ..	1,123,533 ..	1,113,893
Russia	1,200,000 ..	1,256,311 ..	1,098,983 ..	918,838
Belgium	203,446 ..	215,000 ..	334,960 ..	333,119
Holland	123,551 ..	102,411 ..	203,172 ..	178,081
Other Countries.	410,000 ..	325,082 ..	393,236 ..	367,919
	5,852,043	5,552,167	6,760,356	5,990,080

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☞ The Editor is not responsible for statements or opinions contained in articles which are signed, or the source of which is named.

NOTES AND COMMENTS.

Consumption Figures.

The *Produce Markets Review* submits to its readers the complete returns of the consumption of sugar among the Powers, parties to the Brussels Convention, for the first year of its currency. They are:—

	1903-4.	1902-3.	Increase.	Decrease.
United Kingdom	1,409,737	1,460,450	—	50,713
France—Refined	699,030	371,119	327,911	—
Germany—Raw	1,126,432	740,193	386,239	—
Austria-Hungary—Raw	509,567	376,532	133,035	—
Belgium—White	85,431	60,000	25,431	—
Holland—Raw	94,437	77,934	16,503	—
	3,924,634	3,086,228	889,119	50,713
Less Decrease			50,713	
Net Increase			838,406	

Our consumption has *apparently* fallen off 3 per cent.; but the following point must not be overlooked. We used to have for consumptive purposes, say a million tons of foreign refined, and, say, 600,000 tons of raw sugar; total 1,600,000 tons. But now we have not 600,000 tons of raw sugar (passing into the British refineries) in our total, but merely the refined made from it, say 540,000 tons, in which case the total would be 1,540,000 tons, an apparent decrease of 60,000 tons. This more than wipes off the adverse balance given above.

Dietetic Experiments with Sugar.

The *Louisiana Planter* draws attention to some experiments undertaken at the Minnesota Agricultural Experiment Station with regard to the dietetic value of sugar as a human food. Two series of experiments were undertaken. In the first healthy workmen were given a diet which included sugar. In the second, the diet was the same, save for omitting the sugar. With sugar 92·20% of the protein of the ration, 96·08% of its fat, and 95·96% of the carbohydrates were digested, and 91·32% of the energy was available. When sugar was omitted, the values became: Protein, 91·95%; fat, 96·87%; carbohydrates, 96·09%, and energy, 89·34% respectively. According to the calculations 98·9% of the total energy of the sugar was available to the body. "The addition of 5 ounces of sugar per diem to the ration of the working men proved beneficial. It increased the available energy of the ration 25%, and did not affect the digestibility of the other foods with which it was combined. The various nutrients were equally as digestible with as without the sugar. . . . When sugar was added to the ration, the protein was more economically used, 25% more nitrogen, one of the elements of protein being retained in the body. . . . . The value of sugar in a ration depends on its judicious use and combination with other foods. . . . Without under estimating the value and importance of protein in a ration, it is evident that the carbohydrates, as sugar . . . . have a characteristic value, as they supply the bodywith more than half its total available energy."

What is a Modern Mill?

The British sugar machinery manufacturers are always being told of their misdeeds and shortcomings, and it is repeatedly drummed in their ears by unkind American "critics" that they cannot produce a modern sugar mill that will compete for design, finish, and durability with those turned out by any American up-country forge. But as if this were not enough, the *Louisiana Planter* has lately discovered that the British-made mills of 13 years ago were better constructed, and, in short, more deserving of the title "modern," than is the most modern mill of the present day turned out in the United Kingdom! And they have it on the authority of an American consul too. Briefly the facts, as cited in the *Planter* of September 3rd, 1904, are as follows. The situation of such a unique plant is the San Antonio Sugar Refinery, Nicaragua. We read: "One of the most notable additions to the industries of Nicaragua is that of the San Antonio Sugar Refinery. . . . The property consists of about 4,500 acres of very fertile soil, which, according to an analysis made in London, is eminently suitable for the cultivation of sugar cane, cacao, and other tropical products. . . . The estate has been surveyed, and the levels marked, and the plan proves that the whole

property is well adapted for a system of irrigation. . . . A complete sugar-making plant *with the latest modern improvements*,* producing 22 tons of sugar every 24 hours, was purchased *last year* in Glasgow. . . . . A part of this machinery has been transported to San Antonio, and the rest will be shipped as soon as possible so as to have everything ready to grind the first crop of sugar cane in the coming December or January."

There is only one small drawback to the accuracy of this report, and that is, *it is some 13 years old.* The San Antonio factory was erected in *1891*, and the machinery was indeed supplied by a Glasgow firm and is still at work; no complete sugar machinery plant was sent out from Scotland last year to this place, and, unless we are much mistaken, there is no other modern sugar factory in Nicaragua. So that we are here treated by the *Louisiana Planter* to a generously worded description of what a modern sugar factory should be, and then find they have to go back over ten years for their example. The British manufacturer had really better put up his shutters if he cannot produce a larger plant than one that will grind 22 tons of cane per 24 hours.

We understand that the *Planter* has lately endeavoured to enlarge its pages by additional articles and illustrations, and thus increase its circulation. Now while there is no objection to resurrecting old articles of a decade back, yet we believe it is more usual to confine their application to purposes of comparison, and to point out the date of their original appearance. Apart from this, we may say that while we much deplore the well-known fact that British consular reports come out so long after their date of compilation, we are interested to note that in America a consular report received 13 years after the period to which it refers is not considered too late for publication.

Demerara Sugar.

The term "Demerara" when applied to sugar is apparently akin to "that blessed word, Mesopotamia," in the eyes of the British public. At all events, it is clear that it forms a valuable trade mark for the genuine article, as the demand for such sugar by discriminating households is on the increase. It is, therefore, not a matter for surprise if imitations are frequently foisted on buyers. The law as it at present stands is severe on fraudulent imitations, and rightly so, if the latter consist of cheap beet sugars dyed to the characteristic shade of the genuine article. But there seems to be some uncertainty as to the legal constitution of so-called *Demerara* sugar. Wherein lies its special distinction? It is hardly a case of "country of origin," for we have the West India Committee deciding to include within the scope of the term sugars made in

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* The italics are ours (*Ed. I.S.J.*).

other West Indian districts under identical conditions. Against this, it is true, one has to record the conviction of a grocer in London for selling Guatemala sugar as *Demerara;* the evidence was vague and unsatisfactory, but at all events it was shown that the particular sugar while at least equal to real *Demerara* in quality, was not quite identically prepared. Mr. Davson, of the West India Committee, would like to see the term confined to vacuum pan products of the West India Islands and British Guiana, as he considers Demerara itself is not strong enough to monopolise the supply. Yet if the area of production is to be unrestricted, there is nothing to prevent other countries of Central and South America from turning out similar sugar and labelling it "Demerara." Now it seems only in the interests of the British American Colonies that they should have the monopoly of the output for the British market; but as the law at present stands any country which turns out sugar by the vacuum pan process can claim to call it *Demerara* on the ground that it is "of the nature, substance and quality demanded," unless indeed it can be construed that "nature" includes origin, in which case further complications would ensue. We agree with the *Demerara Chronicle* and the West India Committee in expressing a hope that the law may be so amended as to leave no doubt that *Demerara* sugar is defined to be a vacuum pan product made in our Central American colonies. It is important that when the consumer asks for "cane sugar," "beet sugar," or "Demerara," he should know exactly what he is to expect. At present confusion is rife; grocers label any cane sugar, "Demerara;" any refined (whether cane or beet) "cane." This should be stopped by ample legal definitions, and doubtless the West India Committee, in the interests of its clients, will take early steps to have the matter placed on a sounder basis.

THE BRUSSELS CONVENTION.

Those who have worked hard for thirty years to obtain an international agreement for the abolition of bounties on sugar will feel some satisfaction in reading the editorial article in the *Journal des Fabricants de Sucre* of the 5th October. They may be hardened by this time to the snarling complaints of mere political party hacks, the curious economic fallacies of the Cobden Club, and the lamentations of the Confectioners; but they must still be sufficiently sensitive to appreciate with pleasure the true ring of genuine content with which our continental neighbours hail the benefits of free competition and enlarged consumption.

The organ of the French industry says:—

"The Convention, in putting an end to a war of bounties, direct and indirect, onerous for the consumer, perilous for the producer

has furnished the occasion for a simultaneous experiment in many countries of a large reduction of duty. In this way the agreement of the 5th March, 1902, has undoubtedly rendered an immense service to the sugar industry in general. Would it be possible to forget this when the Convention expires? Shall we not still remember, in 1907, the critical situation in which the sugar industry found itself at the time of the Brussels agreement, or shall we revert with a light heart to a state of things of which the fatal consequences were only too manifest to the majority of producers? Are Germany and Austria, knowing now most truly the power of cartels as instruments of oppression to the consumer, to appear again re-establishing these dangerous syndicates? Such a backsliding appears impossible, but we are led, on the contrary, to the conviction that all the States producing and consuming sugar will in the future be inspired above all things in their sugar policy by the main fact, brought clearly to light by the Brussels Convention—the possibility of developing to an indefinite extent the consumption of sugar by reducing its cost."

This is indeed a triumph for the sugar-bounty abolitionists; their opponents will have to show how, according to their doctrine, an increased consumption can be a bad and wicked thing, whether for consumer, producer, Finance Minister or Free Trader. The Cobden Club protest, in the name of Cobden and what they call free trade, against this manifest and beneficent effect of the Brussels Convention; let them make their protest good by sound argument and true reasons or for ever hold their peace.

M. Caillaux, the minister who, in conjunction with M. Rouvier, determined at last to make an end of bounties and thus largely contributed to the success of the negotiations of 1900-1902, contributes an interesting article to *La Petite Gironde*, of the 22nd September, well worth the attention of those who have followed with interest the details of our thirty years' fight against bounties. He recalls the time, quite recent, when the sugar duty in France was 64 francs per 100 kilos., and when the consumption (visible) varied from 400 to 450,000 tons. This, he points out, should have yielded a revenue of 260 to 300 million francs, but it only gave 150 to 200 millions. The balance was used in bounties to the sugar manufacturers (and refiners). This resulted in a greatly stimulated overproduction, coupled with a stationary consumption, crushed by the weight of the heavy duty.

The natural laws of competition had the effect of depriving the manufacturers eventually of the greater part of their bounties, which they were obliged to utilise in sellling sugar below cost price in order to get rid of their surplus production. They were making a (*temporary*) present of 50 to 100 millions per annum to their foreign customers.

And yet it was forbidden to touch this wonderful system! Forbidden to deprive these poor manufacturers of advantages from which they had ceased to derive any profit! Forbidden to relieve the consumer of the excessive duty! And why? Because they had to follow the example of other countries; because Germany and Austria were giving bounties quite as large; because to abolish the bounty would be to put the industry outside any possibility of competing. Those who thus argued hoped that any general agreement would be impossible.

But there came a time when a Finance Minister showed himself ready to treat with the other countries and determined to succeed. After two years of singularly delicate negotiations, and amid a thousand difficulties, he arrived at an agreement, which was signed at Brussels in 1902. M. Caillaux might have added that British skill in diplomacy greatly helped in this happy result.

The Finance Minister at once reduced the sugar duty from 64 to 27 francs. The result was unexpected and more than was ever hoped for. Consumption increased from 371,000 tons to 720,000 tons. Making the necessary corrections for a period of transition M. Caillaux concludes that this is practically an increase from an average consumption of 430,000 tons to one of 660,000 tons. Formerly the consumer paid 1 fr. 10 c. per kilogramme, now he pays 70 centimes. He formerly paid 473 million francs for 430,000 tons, now he pays 462 millions for 662,000 tons.

M. Caillaux defies anyone to cite a case where so great a reduction of duty has been accomplished with so inappreciable a loss of revenue. He finally touches on the lamentations of certain British economists, and asks whether they could reasonably expect that France would persist indefinitely in so gross an economic error. "Are you well founded," he asks, "in complaining that our confectioners should at last work on the same footing as your own? That your West Indian planters should be enabled to restore their industry which our bounty-fed beetroot sugar had crushed out? With general agreement we have restored equality of conditions. Both sides should applaud us."

He might have added that a third interest, the British consumer, should also congratulate him and his colleagues on having averted the grave dangers arising from the sale of a commodity below cost price.

The Java sugar crop is abundant throughout the island, only a few places having suffered from inundation at the beginning of this year, and on the whole the tonnage of cane and its sugar content are remarkably high, with juices above the average purity. The crop will just fall short of 1,000,000 metric tons.

THE FRENCH SYSTEM OF NOT REFINING IN BOND.

The objections we have raised to the French system have so far met with no contradiction. Silence is the policy of the moment, and we accept it as giving consent to our contention.

But though there is silence in the other camp, we find full support from leading members of the Paris press. The *Journal des Débats*, in its issue of the 10th inst., says that the French law is "in contradiction with the principles of the Convention of Brussels, and that it cannot escape being attacked by the other Powers signatories of the Convention."

The writer continues: "In the new law, whatever the department of indirect taxation may say, the duty is levied on the sugar entering the refinery. The creation of drawbacks is thus rendered necessary. The drawbacks can constitute, and in fact become in reality, bounties."

He concludes that the matter will be discussed by the Commission, the Government will receive a reclamation, and will have again to remodel their legislation. They will evidently have to make a new law. These constant changes are a very great trouble to the industry.

In the Journal of the following day the writer continues: "We persist in our opinion that if the French legislation had been put in accord with that of the other contracting States, if they had adopted, as universally throughout Europe, refining in bond, not only would the present difficulties never have existed, but they would have avoided recent incidents which are unfortunate from every point of view. If, as seems to be suggested, there is no occasion to modify the law but only to apply that which exists, what humiliation for our country! It will then be necessary to admit before the Commission either that we have not understood our own law, or that having perfectly understood it we have secretly attempted to evade our undertaking."

The *Journal des Fabricants de Sucre* of the 26th October quotes from our recent article, and also from the remarks in the *Produce Markets' Review*, without making any adverse criticism. It then reproduces portions of the passages quoted above from the *Journal des Débats*, and concludes with the following further quotation:—

"The *Journal des contributions indirectes*, commenting on its part on a recent article published in Germany on the same subject, observes that the export certificates give rise to a special traffic; 'There is, therefore,' remarks the writer, 'a perfectly legitimate traffic in these certificates, and, in consequence, a market quotation for them in the price lists at the foot of the quotations for sugar. The excess of this quotation over the rate of duty, namely, 1 franc per

100k., would be equivalent to a bounty to the Parisian refiner.' The organ of the Government officials reproduces, in conclusion, a very singular piece of information: 'The curious part of this affair is that they assert that the Paris refiners, who have always been opposed to the *détaxe*, are not altogether strangers to the campaign carried on by the English refiners. It appears that they would gladly renounce the benefit obtained by the sale of the certificates, in combination with the refiners of the ports, if they could by this means bring about the abolition of the *détaxe*.'"

Then, to our great satisfaction, the leading article in the *Journal des Fabricants de Sucre* concludes as follows:—

"What can be thought of a fiscal *régime* which gives rise to such criticism and inspires in France no less than abroad so little confidence? It was announced that the Bill concerning the supervision of the refineries, elaborated by the French Government, combined all the necessary guarantees of security, both from the point of view of the abolition of bounties, and of the regularity of the control of the operations. On all these points, they said, this *régime* would not fail to give full satisfaction to the contracting States. But it has been found, it appears, even from the official declarations of the French Delegates at the Permanent Commission at Brussels, that it is far from being so, and that the work of the Government requires serious re-touching in order to attain to the degree of precision indispensable for the loyal carrying out of the Brussels agreement."

The only way to carry out that agreement is to establish refining in bond in France.

SOME NOTES ON LAURENT POLARISCOPE READINGS.*

By George W. Rolfe and Charles Field.

For many years the Laurent polariscope has been the common instrument in our chemical laboratories for the measurement of optical rotation, especially in the determination of specific rotatory powers, which are the constants of calculation in polarimetric analysis.

Till comparatively recently the results obtained with the Laurent polariscopes have been accepted as expressing rotations of the plane of polarisation of the D ray, or ray of standard wave-length. The light used in Laurent measurements, as is well known, is made by vaporising common salt in a powerful Bunsen burner, and filtering the rays through a section of potassium bichromate crystal.

The *saccharimetric* scale of the Laurent polariscope is based on the *specific rotation of quartz*, which was taken as 21·667 at the standard temperature. Later measurements of the specific rotation

* Read at the Providence meeting of the American Chemical Society.

of quartz, even some of more than twenty years ago, give a higher value—21·72 at 20°. As by common usage, the 100-point of the Laurent saccharimeter is a fixed one, equivalent to the rotation value of 21·667, an attempt has been made to reconcile this value to the original definition by stating that this expresses the rotation of quartz at 6°. Obviously, this is merely a matter of definition, the scale being based on a fixed rotation, independently of whether this be the specific rotation of quartz or not.

The Laurent instrument is little used for saccharimetry in this country, the value of the specific rotation of quartz given by the instrument being chiefly of interest as a point of reference for determining the accuracy of its measurements as expressing angular rotations of the plane of polarisation of the standard yellow ray.

In 1890* Lippich published a paper designed to prove, theoretically, that errors of 0·2 per cent. or more necessarily existed in Laurent measurements. As confirmation of this, in the same paper, Lippich also published comparative measurements of the optical rotation of a standard quartz plate made on a Lippich polariscope and two of the Laurent type, the readings of which latter showed variations of forty-five to eighty-two seconds from those of the Lippich polariscope. It should be noted that, in these experiments, Lippich filtered the sodium light through both potassium bichromate and cupric chloride solutions, so that the light he used probably differed appreciably from that designed for the Laurent polariscope.

Landolt† has pointed out that the sodium light as usually employed in polariscopic measurements is not homogeneous, but is made up of light of many wave-lengths, most of them differing slightly from each other, but that such light can be considered as homogeneous light which has a wave-length of the ray which is the resultant in intensity of all the rays emitted. This ray is termed the "*optical centre*" ‡ of the light. In his work on optical rotation, Landolt discusses the different optical centres of light used in polarimetric measurements, but does not consider exactly the kind of light used by Laurent instruments.

In most of the more recent accepted measurements of the specific rotation of quartz the light used has been the yellow rays of the two D lines of the spectrum, separated by spectroscopic methods, either from white light or from sodium flame.

For the Lippich polariscopes, Lippich has designed a ray filter which practically absorbs all light except those rays adjacent to the D lines. This filter purifies the light of incandescent sodium chloride vapour so that its optical centre is practically that of the spectrally purified light. According to Landolt, who describes the preparation of the solutions in detail, it consists of a 10 cm. absorption cell filled

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* "Zur Theorie der Halbschattenpolarimeter," *Wien Sitzungsber* [II.], 99, 695.

† "Optische Drehungsvermögen," p. 360. ‡ "Optischer Schwerpunkt."

with a 6 per cent. solution of potassium bichromate and a 1·5 cm. cell filled with a specially prepared solution of uranyl sulphate.*

Consideration of many published rotation values obtained on Laurent polariscopes, as well as readings of the two instruments of the sugar laboratory of the Massachusetts Institute of Technology, has led us to believe that polariscopes of this type, if of French make, give readings which are concordant within one minute at least, although about 0·2 per cent. lower than those obtained with the Lippich ray filter. As long ago as 1899 one of us published this opinion.†

Quite recently we have made two series of rotation measurements of two standard quartz plates on a Laurent polariscope, one set with the light designed to be used by the Laurent polariscope, sodium chloride light filtered through a section of bichromate crystal; the other set, with sodium chloride light passed through a Lippich ray filter. The instrument used was a Laurent, "large model" made about 1888 by Leon Laurent, of Paris.

The table gives the result of the measurements as well as the saccharimetric readings of the two quartz plates, on the saccharimeters of the Institute laboratory, which are graduated in the standard Ventzke scale for use of Mohr flasks, and their readings also on a triple-shade saccharimeter of the United States Department of Agriculture, which latter readings were made by Dr. Wiley in 1898, and obviously are on the true cubic centimeter scale.

The saccharimetric readings of "Quartz A" plate show that, within a small error, it is a millimeter in thickness.‡ On this account it is interesting to note that the value given with the ordinary light used with the Laurent polariscope is practically that obtained for the specific rotation of quartz by the *earlier* investigators, while that given by the Lippich light closely approximates to the *modern* value.§ The results, as a whole, have led us to believe that the difference in values obtained by the Lippich and Laurent measurements are not due to the imperfections of the Laurent instrument, but to the kind of light used, at least up to the precision required in chemical laboratory measurements, or 0·1 per cent. of the values obtained.

The greater convenience of the Laurent polariscope, owing to its end-point adjustment being independent of the position of the polariser for the regulation of the light intensity, as well as the advantage of the bichromate section over the Lippich ray filter, which absorbs a large percentage of light and soon deteriorates, owing to the oxidation of the uranium solution, makes the Laurent more advantageous than the Lippich for general laboratory measurements. Our results show that Laurent measurements can be converted to the standard of

* Lippich: *Ztschr. für Instr.*, 12, 340; Landolt: "Optische Drehungsvermögen," p. 362.

† This Journal, 21 R, 105 (1899).

‡ Landolt: "Optische Drehungsvermögen" (First Edition), p. 162. The plate was always placed in the instruments in a definite axial position, but we have been unable to detect any difference in its readings in different positions.

§ Landolt: "Optische Drehungsvermögen," p. 130.

spectrally purified light by increasing their value 0·2 per cent. The tabulated light factors calculated from the different rotation and saccharimetric values will, it is hoped, explain some of the different values which are given indiscriminately, and, in fact, without proper explanation in the various publications dealing with optical rotation.

It may be unnecessary to point out that Rimbach,* Landolt,† and others have shown that the light factor of a quartz-wedge saccharimeter may vary with the nature of the substance measured. This is on account of the difference in the rotary dispersion of quartz and the solution measured, the result being that all the rays of the spectrum whose planes are rotated by the solution are not restored exactly to their original angular positions by a section of oppositely rotating quartz of one definite thickness. Hence no position of the quartz compensation wedges will exactly restore the original light effect of the end-point when the solution is placed in the instrument, and a more or less parti-coloured field is given in shadow saccharimeters. If the dispersion difference is slight, this can be obviated and an evenly tinted field obtained by absorbing the rays of the blue end of the spectrum by means of a ray filter of bichromate solution, or somewhat less effectively, but more conveniently by means of a piece of brown (carbon) tinted glass. The ray filter, however, in the case of the quartz-wedge saccharimeter, merely assists in obtaining a more precise end-point. The light factor, as determined by a solution of commercial glucose, for instance, will differ appreciably from that obtained with quartz. Even cane sugar solutions differ sufficiently from quartz in rotary dispersion to give light factors of slightly different value.

Hence, it is imperative, in stating that the light factor of a saccharimeter is a certain value, that reference should be made (1) to the exact nature of the light used in the rotation readings, (2) the saccharimetric standard of the scale of the quartz-wedge instrument, (3) the nature of the substance measured, and (4), obviously, the temperature at which the comparisons are made. It would seem as if these conditions of measurement ought to be well known, but they are singularly ignored in statements in publications on the subject, to the confusion of most readers.

READINGS AT 20°

	(1) Sacch. readings, orig. Ventzke scale.	(2) Sacch. readings, true cc. scale.	(3) Laurent readings, orig. light.	(4) Laurent readings, Lippich Ray-filter.
Quartz A ..	62·66	62·45	21·667	21·719
Quartz D....	96·02	95·77	33·200	33·284

CALCULATED LIGHT FACTORS.

	From (1) and (3).	From (1) and (4).	From (2) and (3).	From (2) and (4).
Quartz A.. ..	0·3458	0·3466	0·3469	0·3478
Quartz D ...	0·3458	0·3466	0·3467	0·3475

Journ. Amer. Chem. Soc.

* *Ber. d. chem. Ges.*, 27, 2282. † *Ibid.*, 21, 191.

MAIZE OIL.

By Sigmund Stein.

(Sugar Expert, Liverpool.)

The question of the manufacture of glucose from maize, and the utilisation of the by-products of this manufacture, has been ventilated of late in many quarters, not only in this country but also on the continent of Europe and in many parts of America. Amongst the several by-products which result from this manufacture "Maize Oil" takes a foremost place.

To our American friends, with their large glucose factories in the United States, belongs the credit of showing us the rational way of utilising the by-products of the glucose manufacture. Since that time, however, the question has been studied in other countries, both in England and in Germany, and I venture to state that the manufacture of maize oil as a by-product will soon be spreading as a new and flourishing industry.

If the grain of the maize plant be examined, one will find that the pointed end of the grain is soft, and that this pliable mass can be easily removed from the starchy part of the grain with a pen-knife. This soft part is called the "germ." If this germ is pressed between the fingers an oily substance will exude. The germ is separated from the starchy matter by crushing the maize (before it is thoroughly ground) between corrugated rollers. The crushed maize is then allowed to run into a receiver of starchy water. The germ is lighter than the starch and so floats on the surface of the water, and is carried off by an outlet pipe, which is situated just above the level of the water in the vessel. The germ is afterwards collected and washed in a sieve which revolves slowly and retains the germ, but allows the starchy water to run away. The wet germ is then put into a centrifugal machine to be freed from the adhering water. As the germ is not yet dry enough it is afterwards subjected to a drying process in hot air. Having been properly dried it is ground and pressed into cakes. The cakes are submitted to hydraulic pressure, to the extent of 4,000 lbs. per square inch. As a consequence of this the maize oil runs off and is collected in a cistern. The dry germ contains from 52 to 53% of maize oil. But all this oil could not be gained, as a certain percentage (about one-fifth) remains in the cake, and only about 40% nett of the contents of the germ could be obtained. Ordinary maize contains from 6 to 7% of oil. The manufacture of "Maize Oil" forms a great industry in the United States of America. If we consider that about 250,000 bushels of maize are worked up daily, and about 5·5% of oil is obtained from the maize, one will understand that maize oil manufacture is no small affair. The export

of this maize oil from the United States increased from two-and-a-half million gallons in 1898 to six million gallons in 1903. The export of maize oil cake is in the same proportion.

Maize oil, having a light, yellow amber colour, is perfectly transparent, and has a pleasant taste.

I have lately analysed some maize oil at the request of friends, and with their permission I give below my analsis of this oil as manufactured in the United States. Maize oil contains olein, palmitin and stearine, and some volatile oil compounds. It has a characteristic reaction. Nitric acid colours it to a reddish brown; sulphuric acid forms a dark green colour. A mixture of sulphuric acid and nitric acid forms a dark red colour.

This oil is properly speaking a new product, but in spite of this it has already a long list of applications in various industries, and has become an important article of commerce. A large quantity of this commodity is shipped to Europe, but when it arrives here it loses its name and is sold under various other titles. On account of its pleasant taste, it is mixed with olive oil or used instead of it as salad oil. It is used in the manufacture of many paints and colours; soap, especially soft soap, India rubber, and leather. It is likewise used instead of rape or colza oil for lighting purposes.

On account of its advantage of not becoming rancid it is used instead of olive oil for baking purposes. It is employed in wool spinning for fattening the wool; as a lubricant, and for many other purposes.

I may say that the profit a glucose and starch manufacturer receives is represented by the value of the maize oil he produces, and I have been informed that a ton of "Maize Oil," as per sample analysed below, would be worth to-day £23 10s.

Analysis of Maize Oil.

Specific gravity at 15° C. = ·9199.
Degrees viscosity at 15° C. = 19·7.
Freezing point = — 13° C.
Contents of un-soluble fatty acids (Hehner's figure) 95·66.
Volatile fatty acids (Reichert-Meissl's figure) ·73.
Saponifaction coefficient (according to Koettstorffer) 188·3.
Amount of iodine (Huebl's figure) absorbable:—

(*a*) For fat, 83·6.
(*b*) For fatty acids, 85·9.

Licht's first estimate of the 1904-05 beet campaign in Europe shows a decrease of over 700,000 tons as compared with the 1903-04 campaign just completed.

FRANCE.

Results of the Campaign of 1903-04.

The number of factories at work during the season, which closed on the 31st August last, was 292, against 319 in 1902-03, and 332 in 1901-02.

The quantity of beets worked up was 6,441,500 metric tons, as compared with 6,266,946 in 1902-03, and 9,350,852 in 1901-02. The yield per hectare was 27,500 kg. of beets as compared with 25,200 kg. in the preceding campaign.

The sugar production (in refined sugar value) for the three last campaigns is given as follows:—

	Metric tons.	Yields of sugar Per cent. of beet.
1901-02	1,051,930	11 24
1902-03	776,158	12·38
1903-04	727,267	11·29

The consumption of sugar increased by 88%, being 371,119 metric tons in 1902-03 and 699,030 tons in 1903-04.*

SCIENCE IN SUGAR PRODUCTION.

By T. H. P. Heriot, F.C.S.

(Continued from page 477.)

4. Manufacture.—(*Concluded.*)

(e) Separation of the Crystals in the form of Dry Sugar.

The foregoing processes of evaporation by multiple effect and vacum pan yield a semi-solid mixture containing some 63% of sugar crystals and 37% of fluid molasses which have finally to be separated in the "curing" department of the factory.

The Cane.

1. Percolation.—An outline of the old muscovado process of sugar making will serve to indicate one of the earliest methods of separating sugar in the dry state.

The juice, expressed by the mill, passed to the copperwall where it was limed, heated, and skimmed in the clarifying coppers and concentrated by vigorous boiling in a series of evaporating coppers, the resulting syrup being further evaporated in the last copper until it constituted a highly supersaturated solution of sugar which spontaneously crystallised on cooling. This was next ladled into shallow wooden vessels, or coolers, in which it remained for two or three days; the crystallised material being subsequently dug out and conveyed to the curing house, a capacious building adjoining the

* Sachs says the real figures are probably 420,000 tons and 600,000 tons, an actual increase of only 43%.

factory. Here were to be seen rows of hogsheads arranged upright upon an open framework of strong joists, and overlying a cistern extending from end to end of the curing house, below the floor level. The bottom of every hogshead was pierced with several holes, loosely plugged with twisted cane leaves or plantain stalks, in such a manner that when the hogsheads were filled with the crystallised syrup from the coolers, the molasses slowly escaped through the perforated bottoms and drained into the cistern below. This curing operation required from three to four weeks after which period the hogsheads were headed up and shipped. Such muscovado is a very impure form of crystallised sugar, containing a considerable quantity of molasses which leak from the hogsheads during shipment to European markets. It is still manufactured in Barbados and other West Indian Islands.

2. Washing.—The very imperfect separation above described led to attemps to wash out the residual molasses from the crystals by means of water and spirit. For this purpose, the crystallised material was transferred from the coolers to small vessels resembling inverted cones, from which the molasses drained off by a hole in the apex of the cone. When this was more or less complete, a pasty mixture of clay and water was poured upon the upper surface of the sugar at the base of the cone. This latter operation, termed "claying," caused a very gradual percolation of water through the pot, diluting the residual molasses adhering to the crystals. A more perfect separation was thus brought about but the wash water dissolved some of the crystallised sugar. This defect was remedied by substituting strong spirit for the water, but neither method of washing was adopted to any large extent in the West Indian industry.

3. Percolation under Pressure.—In this method atmospheric pressure was utilised for draining the molasses from the crystals. The apparatus comprised a chamber having a perforated false bottom covered with fine wire gauze, upon which the crystallised masse-cuite was placed. On exhausting the air from the space underlying the false bottom of the chamber by means of a vacuum pump, the pressure of the external atmosphere was brought to bear upon the surface of the crystallised material, the fluid molasses being thus carried through the perforated bottom by the air entering the vacuum chamber, leaving the sugar crystals above the wire gauze in a more or less dried condition. The success of this method required that the crystals should be large and well formed, which greatly restricted its general application.

4. Centrifugal Separators.—The muscovado process held its own until the West Indian planter followed his rivals example in adopting centrifugal methods of separation, which must therefore be described under :—

The Beet.

1. Percolation.—The earliest methods of separating beet crystals in the dry form appear to have been borrowed from the British refiner rather than from the cane industry, although the principle of drainage or percolation is identical with that described above.

2. Centrifugal Separators.—The principle of these machines is based on the fact that a body revolving round a central point tends to fly off at a tangent with a force proportionate to its speed of revolution.

The history of these interesting machines is very difficult to trace, but the numerous types of centrifugals employed in various modern industries appear to owe their origin to the "hydro-extractor" designed for drying textile fabrics. This consists of a drum with perforated sides into which the wet fabrics are introduced. When rapidly rotated by suitable driving gear the fabrics are thrown against the interior, perforated walls of the drum with a force several hundred times greater than that of gravity; the water, being free to pass through the perforations, escapes as a spray.

In the year 1850 some thirty British patents were taken out for similar machines adapted for use in the sugar industry, and Messrs. Manlove, Alliott and Seyrig appear to have been the first constructors of such machines, which were adopted with great success in refineries. Subsequently the same firm furnished drawings to Messrs. Cail, of France, and it is highly probable that the centrifugal machines first used in the beet industry were constructed from these drawings. Various improvements were made, and eventually two types of "turbines" were adopted in Continental sucreries—the French type, driven from above, and the Austrian type, driven from below the basket or drum. Finally, an American type of turbine, known as the "Weston," made its appearance, and which has been generally adopted in the West Indian cane industry.

The mechanical distinctions between these three types need not detain us, the essential principal of separating the molasses from the crystals being identical in all three. The sugar centrifugal, or turbine, may be briefly described as a cylindrical metal basket with perforated sides, the latter being lined with fine wire gauze. This basket is mounted on a vertical spindle, which can be rotated at a speed of from 1,000 to 1,500 revolutions per minute; so that, when charged and set in motion, the contained masse-cuite is thrown against the gauze lining, through which the molasses escape into a stationary outer casing, and thence pass to an external receiver. The crystals are thus cured in a very few minutes, and, after bringing the basket to rest, they are discharged through a central outlet in the bottom of the basket and casing, and fall upon a mechanical conveyor.

The driving power may be transmitted to the spindle of the basket either indirectly by friction gear or driving belt, or directly by a pelton wheel driven by water jets, or by an electric motor attached to the spindle. These centrifugal machines operate intermittently on relatively small quantities of masse-cuite, so that a considerable number are required in a sucrerie of moderate size.

The continuous-acting turbine, invented by M. M. Szezentowsky and Piatkowsky is the latest development of this class of machinery. By a modification in the form of the basket, the turbined sugar crystals are thrown off from the upper rim, whilst a continuous feed of masse-cuite is admitted near the bottom of the basket or drum, the latter being driven at its full speed without interruption. The cured sugar is caught upon a circular belt surrounding the top of the turbine, and gravitates to a mechanical conveyor; the molasses escape through the perforated sides of the basket, and are separately collected.

During the process of turbining, the bulk of the molasses separates very rapidly, but the last traces adhere tenaciously to the surfaces of the crystals, and are very difficult to remove. In the manufacture of white sugar it is customary to displace the residual traces of molasses by washing the crystalline material whilst the basket is in motion. A moderately pure, saturated syrup may be used for this purpose without any loss of crystallised sugar, such as occurs when water or steam are employed for this purpose.

The cured sugar is finally bagged off either in a slightly moist condition (refining crystals) or after drying by exposure to the air in thin layers or in a hot air drying cylinder.

This concludes our review of the manufacture of sugar from the raw materials of the two industries. Before leaving the factory we may glance at:—

5. The By-Products.

These may be conveniently grouped under three heads, namely, those peculiar to each industry and those common to both.

1. *Cane Products.*

Exhausted Cane Fibre.—An important feature of the modern cane factory is the production of sufficient steam for driving the machinery and evaporating the juice without incurring a fuel bill. In the days of the Copperwall a serious item in the cost of manufacture was the labour required to dry the megass in the factory yard, but with improved types of furnaces and steam boilers used to-day, the so-called "wet" megass (containing some 50% of moisture) may be effectively burnt the moment it leaves the cane mill. We need not here describe the various furnaces and boilers which have found favour from time to time, but we should record that the ideal steam

raising plant has been found in the "Climax" water-tube boiler, adapted for megass firing in the West Indies, by Mr. Peter Abel.

So far from having, as formerly, to supplement the supply of megass by wood and coal, the problem of the near future will be to discover how to utilise the increasing surplus of megass which has to be dumped outside the factory. Several attempts have been made to utilise this fibre for paper making, but without financial profit. The cost of transporting such bulky material from the factory to the field is probably barely covered by its value as a manure. When burnt, the megass-ashes contain all the mineral constituents in a much more concentrated form, but, at the high temperature prevailing in the furnace, this ash readily fuses into a vitreous slag which has little if any manurial value.

The highly absorbent nature of the megass has been utilised by Mr. Hughes as the basis of his patented "Molascuit" cattle food, which consists essentially of a mixture of finely divided megass with four times its weight of molasses. The manufacture of this food is being taken up in the West Indies with considerable success.

2. *Beet Products.*

Exhausted Beet Slices.—The first by-product of the beet sucrerie differs remarkably from the corresponding residue from the cane, referred to above. As discharged from the diffusion battery, the exhausted slices are saturated with the final diffusion water, and represent about 85 % of the weight of the original roots. In this wet condition the slices are practically valueless, but by the graduated pressure of suitable machinery the bulk of the water is squeezed out and a "pressed pulp" obtained, which forms an excellent cattle food, as will be seen from the following analysis:—

Analysis of Pressed Pulp.

Water	89·8
Ash	·6
Albuminoids	·9
Cellulose	2·4
Other carbohydrates	6·1
Fat	·2
	100·0

This by-product, representing from 20 to 30 % of the weight of the roots sent to the sucrerie, is carried away in the farmers' carts which would otherwise return empty. Its value as fodder is about one-fourth of that of the whole roots (the saccharine juice having been extracted and replaced by water), and is worth about 10s. per ton. This and certain other by-products are given gratuitously to the farmer, enabling him to sell his crop at a

very favourable price for the sugar fabricant and with considerable profit to himself.

The importance of this by-product of the beet industry may be judged from the following figures* :—Ten million tons of beetroot are produced in Germany annually, which yield at least five million tons of exhausted slices, all of which are used for cattle feeding, and represent in Germany alone a value of £2,500,000. According to many experiments, 1 ton of beetroot slices produces 30 pounds of meat. The 5,000,000 tons of slices are therefore equal to 150,000,000 pounds of meat, or meat value, in the cattle. If these pounds of meat are worth 6d. per pound, we arrive at the large sum of £3,750,000.

Saturation Lime is another by-product given gratis to the farmer, and consists of the insoluble matter filtered from the juice during the process of carbonatation. It forms an excellent manure, as will be seen from the following analysis quoted by Stein :—

Water	34·5
Organic matter	14·5
Potassium salts	1·2
Phosphoric acid	1·5
Nitrogen	1·2
Lime	41·5
Sand	3·3
Other substances	2·3
	100·0

3. Products common to both industries.

Molasses.—Muscovado molasses from the cane were formerly much valued, and sold at about 1s. per gallon in America, where sugar refiners re-boiled it, and extracted a small proportion of crystallised sugar. Improved methods of manufacture have long enabled the raw sugar manufacturer to recover all the available sugar from this by-product; his markets in America having been practically closed by an increased duty on such produce.

The final molasses from the cane and beet contain a considerable quantity of sugar and glucose, and, as both these sugars can be easily converted into alcohol by the action of yeast, a distillery is an almost essential adjunct to the modern sugar factory. Here the molasses are heavily diluted with water, fermented, and distilled, yielding a more or less rectified spirit. The West Indian product is generally coloured with caramel and sold as rum, whilst the beet distillery produces a more neutral spirit, which finds various applications. The manufacture of alcohol is an industry in itself, and does not come

* "Sugar," by Sigmund Stein.

within the scope of our present inquiry. We may state, however, that the beet distillery is conducted on strictly scientific lines, and with the most approved types of stills, of exclusively Continental manufacture. The diluted beet molasses are sterilised before entering the fermenting vats, after which fermentation is brought about by inoculating each vat of liquid with artificial yeasts prepared from pure cultures.

The production of rum in the West Indies is more generally regarded as the cheapest method of getting rid of the molasses rather than as an industry to be developed on its own account. It is true that Jamaica has long enjoyed a world-wide reputation for the quality and flavour of its rum, but this success has been slowly gained by tentative experience rather than by the direct application of scientific methods. Moreover, Jamaica rum is not produced from the true by-product of the sugar factory, but from high grade molasses containing a considerable quantity of sugar which has therefore to be sacrificed. Fermentation of the wash, or diluted molasses, occurs spontaneously in the tropics, the air of the factory supplying numerous types of yeast, but no attempt has yet been made to introduce modern methods of fermentation by means of artificial yeasts cultivated in sterilised media. The spent wash, or "dunder," from which the alcohol has been distilled is again utilised in Jamaica for diluting the molasses in the fermenting vats; in the West Indies generally this final residue is discharged into the nearest stream.

The spent wash, or "vinasses," of the beet distillery is further utilised for the extraction of potash salts, which constitute 70% of the mineral matter contained in the original beet-molasses. This is effected by concentrating the vinasses to a density of about 20 Baume in a multiple evaporator and then calcining the residue in suitable furnaces. The hot gases evolved by the combustion of the same passes through a multitubular boiler and evolves the steam necessary to heat the first vessel of the multiple evaporator. By this ingenious economy of heat the evaporation of the vinasses is effected by the combustion of the evaporated material, and the mineral residue, or ash, is sold as crude potash to the soap boiler.

The mineral matter of cane molasses also contain potash to the extent of about 35%. Special furnaces have been successfully designed with the two-fold object of producing steam by the combustion of the molasses alone, and of recovering the valuable potash salts from the resulting ashes, but such vigorous methods of economy have not as yet found favour in the West Indian industry.

(*To be continued.*)

ON THE DETERMINATION OF THE WEIGHT OF CANES WORKED, THE EXTRACTION BY MILLING, AND THE RICHNESS OF THE CANE.

By M.M. Louis Bonnin and Edouard Haddon.*

In the *Bulletin de l'Association des Chimistes* of November, 1901, we published a paper on the determination of the extraction by milling in cane factories, which was followed, some time later, by an article on the same subject in a local journal.

The memoir which appeared in the Bulletin was replied to by our colleague in Java, H. C. Prinsen Geerligs, to which we need not here refer. Concerning the article published in the *Mauritius Journal*, this has been the subject of a long discussion in the local press between ourselves and M. L. Giraud, chemist for Mauritius, which has induced us to make further experiments on this important subject.

In Mauritius and also, we believe, in other colonies, it is not the rule to deduct any tare from the gross weight of the canes. We have called attention to this point, and have shown that a very sensible difference exists between the weight of the canes at the factory balance and that of the canes actually crushed in the mills.

M. Giraud, our critic at Mauritius, does not admit this; and, in his replies, he endeavours to prove that we had been in error when we proposed to deduct from the weight of raw juice, the weight of maceration water added to the megass, in the determination of the extraction by milling.

To clearly understand what follows, the reader should refer to our former memoir, and to the reply from H. C. Prinsen Geerligs (see the *Bulletin* for March, 1900, p. 621), and we will here briefly resume what we then wrote.

By extraction is meant the weight of juice obtained from 100 parts of cane. If 100 kilos of cane are crushed yielding 70 kilos of juice and 30 kilos of megass, the juice will represent 70 % of the weight of the cane, and the extraction will be equal to 70.

When it is impossible to collect, without loss, and to weigh all the megass produced, resource is had to another method, giving the same result, and which consists in accurately measuring the juice yielded by a known weight of cane, and observing its density.

When macerating the megass, the weight of the juice is also determined from its volume and density; but, in this case, the weight of the water added must be deducted from that of the diluted juice.

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* Translated from *Le Bulletin de l'Association des Chimistes.*

Since that time, and after recent experiments, we have finally become convinced that a small quantity of water may indeed remain in the megass, as our critics maintain, but only when the moisture of the megass is not carefully controlled.

Before referring to our method of determining the true extraction by the mill, we shall attempt to show that a difference exists between the weight of canes bought and that of the canes worked, and how this may be accounted for.

In our opinion, this difference has given rise to the recent disputes, and has led to so many special methods for determining the extraction.

In one of our replies to our critics, we mentioned a loss of 2·5 % between the weight of the canes when actually weighed and when crushed, but this loss is quite small, for we have since found a difference of over 8 %.

In certain cases the trash alone constitutes a loss of 2 %. When to this is added the loss by evaporation and mechanical losses during transport, it will be evident that a loss of 8 and even of 10 % is not exaggerated.

The *Int. Sugar Journal* recently published an article by Professor Weinberg, in which some very large differences are recorded, and from which the following figures are extracted :—

Loss in Weight of Canes.	Per cent.
After 24 hours	2·7
,, 2 days	5·3
,, 3 ,,	10·4
,, 4 ,,	13·4
Loss in Sugar contained in the Cane.	**Per cent.**
After 24 hours	1·3
,, 2 days	11·7
,, 3 ,,	28·4
,, 4 ,,	33·4
,, 5 ,,	38·9

These analyses were made by means of the coefficient 0·85, and not by direct analysis.

These results of M. Weinberg surprised us for we have not, as yet, met with such enormous losses. We immediately made some experiments, but, before stating the results obtained, we would point out that these experiments are exceedingly difficult for the following reasons :—

It being necessary to treat two lots of canes—one of which is analysed immediately at the commencement of the experiment, the

other, or "test" lot not being analysed until some days later—we have therefore to assume that the initial richness of the two lots is identical.

Let us suppose that the conditions are most favourable, and that we select, with the greatest care, two lots of 20 canes identical in appearance (the same length, diameter, and the same distance between the nodes), it might then be assumed that these two lots were of equal saccharine richness, but we could never be certain since we know that two canes, having grown side by side from the same stool, generally vary in composition.

Some degree of uncertainty on this point must therefore always remain, and, at the close of the experiment, any difference in saccharine richness between the first and the "test" lots should not be regarded as definite and absolute.

With these reservations, we proceed to the results of our experiments.

First Experiment.

The richness of the cane was determined by direct analysis—that is to say, the analysis of the juice and that of the megass.

A. A sample consisting of 20 "Louzier" canes was taken two days after being cut:—

Degrees Baumé of juice	10·3
Sucrose	14·83
Glucose coefficient	1·91
Purity	86·18
Acidity	0·74

B. A sample of 20 "Louzier" canes, physically identical with those of lot "A."

After six days exposure to the sun, during which time they received 0·90 inches of rain in two showers, the juice had the following composition:—

Degrees Baumé	11·6
Sucrose	13·06
Glucose coefficient	22·8
Purity	75·29
Acidity	0·94

The loss in weight was 5·81 per cent., and the loss in sugar on the sugar contained in the cane was 11·94 per cent., but as 94·19 of these canes correspond to 100 of fresh canes this loss of 11·94 is equal to 17·06 per cent. of the sugar originally contained in the fresh cane.

SECOND EXPERIMENT.

C. A sample of "Big Tanna," freshly cut, yielded juice of the following composition:—

Degrees Baumé	10·5
Sucrose	13·62
Glucose coefficient	7·6
Purity	84·39
Acidity	0·96

D. A sample of "Big Tanna," physically identical with lot "C," after four days exposure to the sun (without rain):—

Degrees Baumé	10·9
Sucrose	12·62
Glucose coefficient	15·09
Acidity	2·14

These canes had successively lost the following weights:—

	Per cent.
After 24 hours	4·3
,, 2 days	5·99
,, 3 ,,	7·99
,, 4 ,,	9·52

After these four days, the loss in sugar on the sugar contained in the cane was 7·35 per cent., which, calculated on 100 parts of fresh cane, becomes 9·59 per cent.

In practice the loss in weight and in sugar is, we believe, much lower, for the canes, being in heaps, are not all equally exposed to the sun.

This loss also depends on the situation of the Usine, for the weighings may sometimes be made at a great distance. The truck starts, stops, is restarted, shunted, and finally arrives at its destination after being on the road for some 12, 24 or 48 hours. It is, therefore, almost impossible that the weight on arrival should be equal to the weight at the time of departure, and yet this weight is taken to represent the weight of canes worked up.

We here quote an opinion of M. Pellet (*Bulletin de l'Association*, July and August, 1897, p. 72). Speaking of the saccharine richness of the cane, M. Pellet says: But whatever the result obtained, it does not represent the true richness of the cane. It is the richness of the sample at the moment of working, but not of the 100 kilos of cane entering the weighing machine.

The cane undergoes dessication; it is, moreover, never free from impurities, however carefully cleaned in the field. There are the

débris of leaves, of soil, and of broken cane which never enter the mills or cane-cutters. There are also bruised canes having lost some of their juice, and gnawed canes.

All these constitute a loss varying from 1 to 2·5 per cent. of the sugar which must be accounted for (p. 73).

M. Pellet adds: to make allowance for the loss in weight of the cane it is necessary to always multiply the results by 0·99.

Our critics absolutely refuse to admit the existence of such a loss, but it appears to us to be established in a sufficiently convincing manner by the foregoing results, and that it should be recognised as a fact in the future.

Let us now try to determine this loss, and see if we can estimate the weight of canes actually crushed. For this purpose we reduce all volumetric data to the mean temperature of the factory, which is 25° C, by the use of the following tables :—

DEGREES "VIVIEN" CORRESPONDING TO THE DENSITY AT 25° C.

Density.	Degrees Vivien.	Density.	Degrees Vivien.	Density.	Degrees Vivien.	Density.	Degrees Vivien.	Density.	Degrees Vivien.
0·1	1·000	2·1	6·233	4·1	11·438	6·1	16·766	8·1	22·033
0·2	1·262	2·2	6·384	4·2	11·696	6·2	17·000	8·2	22·333
0·3	1·522	2·3	6·744	4·3	11·960	6·3	17·265	8·3	22·552
0·4	1·784	2·4	7·059	4·4	12·220	6·4	17·544	8·4	22·781
0·5	2·044	2·5	7·266	4·5	12·481	6·5	17·814	8·5	23·130
0·6	2·206	2·6	7·526	4·6	12·741	6·6	18·063	8·6	23·449
0·7	2·567	2·7	7·788	4·7	13·000	6·7	18·300	8·7	23·640
0·8	2·828	2·8	8·049	4·8	13·263	6·8	18·553	8·8	23·830
0·9	3·090	2·9	8·310	4·9	13·524	6·9	18·799	8·9	24·030
1·0	3·353	3·0	8·570	5·0	13·786	7·0	19·046	9·0	24·431
1·1	3·615	3·1	8·731	5·1	14·041	7·1	19·296	9·1	24·620
1·2	3·877	3·2	9·091	5·2	14·309	7·2	19·546	9·2	24·875
1·3	4·138	3·3	9·352	5·3	14·590	7·3	19·950	9·3	25·175
1·4	4·401	3·4	9·613	5·4	14·831	7·4	20·223	9·4	25·423
1·5	4·665	3·5	9·874	5·5	15·093	7·5	20·442	9·5	25·700
1·6	4·922	3·6	10·134	5·6	15·355	7·6	20·668	9 6	25·922
1·7	5·183	3·7	10·395	5·7	15·617	7·7	20·887	9·7	26·200
1·8	5·442	3·8	10·656	5·8	15·880	7·8	21·147	9·8	26·500
1·9	5·702	3·9	10·917	5·9	16·142	7·9	21·446	9·9	26·800
2·0	5·958	4·0	11·177	6·0	16·467	8·0	21·760	10·0	27·118

SUCROSE PER 100 CC. SOLUTION DILUTED FROM 100 TO 110 CC.
NORMAL WEIGHT, 16·29.

Degree.	Sucrose per 100 cc.	Degree.	Sucrose per 100 cc.	Degree.	Sucrose per 100 cc.	Degree.	Sucrose per 100 cc.	Degree.	Sucrose per 100 cc.
1	0·179	23	4·121	45	8·063	67	12·005	89	15·947
2	0·358	24	4·300	46	8·242	68	12·184	90	16·127
3	0·537	25	4·479	47	8·421	69	12·364	91	16·306
4	0·716	26	4·658	48	8·601	70	12·543	92	16·485
5	0·895	27	4·838	49	8·780	71	12·722	93	16·664
6	1·075	28	5·017	50	8·959	72	12·901	94	16·843
7	1·254	29	5·196	51	9·138	73	13·080	95	17·023
8	1·433	30	5·375	52	9·317	74	13·260	96	17·202
9	1·612	31	5·554	53	9·497	75	13·439	97	17·381
10	1·791	32	5·734	54	9·676	76	13·618	98	17·560
11	1·971	33	5·913	55	9·855	77	13·797	99	17·739
12	2·150	34	6·092	56	10·034	78	13·976	100	17·919
13	2·329	35	6·271	57	10·213	79	14·156		
14	2·508	36	6·450	58	10·393	80	14·333	0·1	0·017
15	2·687	37	6·630	59	10·572	81	14·514	0·2	0·035
16	2·867	38	6·809	60	10·751	82	14·693	0·3	0·053
17	3·046	39	6·988	61	10·930	83	14·872	0·4	0·071
18	3·225	40	7·167	62	11·109	84	15·051	0·5	0·089
19	3·404	41	7·346	63	11·288	85	15·231	0·6	0·107
20	3·580	42	7·525	64	11·468	86	15·410	0·7	0·125
21	3·762	43	7·705	65	11·647	87	15·589	0·8	0·143
22	3·942	44	7·884	66	11·826	88	15·768	0·9	0·161

TABLE FOR THE CORRECTION OF TEMPERATURE FOR REDUCING DENSITIES TO 25° CENTIGRADE.

	Densities from 0 to 7.	Above 7.
20°	— 0·12	— 0·12
21°	— 0·10	— 0·10
22°	— 0·07	— 0·08
23°	— 0·05	— 0·05
24°	— 0·02	— 0·02
25°	0·00	0·00
26°	+ 0·02	+ 0·02
27°	+ 0·05	+ 0·07
28°	+ 0·07	+ 0·10
29°	+ 0·10	+ 0·12
30°	+ 0·12	+ 0·15
31°	+ 0·15	+ 0·18
32°	+ 0·17	+ 0·20
33°	+ 0·19	+ 0·22

Volumes of Saccharine Solutions at Different Temperatures.

Temperature.	10 per cent.	20 per cent.	30 per cent.	40 per cent.
20°	99·85	99·84	99·83	99·82
21°	99·88	99·87	99·86	99·85
22°	99·91	99·90	99·90	99·89
23°	99·94	99·93	99·93	99·92
24°	99·97	99·97	99·97	99·96
25°	100·0	100·0	100·0	100·0
26°	100·032	100·03	100·03	100·04
27°	100·064	100·06	100·07	100·08
28°	100·096	100·10	100·10	100·11
29°	100·12	100·13	100·14	100·15
30°	100·16	100·17	100·18	100·19
31°	100·19	100·20	100·21	100·23
32°	100·23	100·24	100·25	100·27
33°	100·26	100·27	100·28	100·31
34°	100·30	100·31	100·32	100·35
35°	100·34	100·35	100·36	100·39

Volume of Water at Different Temperatures.

1 volume at 20° = 1·101 to 25° Centigrade.
,, 25° = 1·000 ,,
,, 30° = 0·998 ,,
,, 35° = 0·996 ,,
,, 40° = 0·995 ,,
,, 45° = 0·993 ,,
,, 50° = 0·991 ,,
,, 55° = 0·988 ,,
,, 60° = 0·986 ,,
,, 65° = 0·983 ,,
,, 70° = 0·980 ,,
,, 75° = 0·978 ,,
,, 80° = 0·975 ,,

1 litre of water at 25° C weighs 0·996 kilos.

Taking now the following data from the factory records:—

Hectolitres of maceration water at 50°, reduced to 25° ..	23060·02
,, ,, dilute juice	249423·38
,, ,, sulphitation juice	254609·86

COMPOSITION OF THE JUICES.

	First Mill.	Dilute Juice.	Sulph. Juice.
Degrees Baumé	10·8	9·85	9·80
Density at 25° C	8·11	7·36	7·30
Sucrose per 100 c.c.	18·61	16·72	16·18
Glucose co-efficient	5·5	6·2	7·5
Purity	84·4	82·7	81·1

Anhydrous fibre in the cane	11·26
Sucrose per 100 megass	5·3
Moisture of the megass	45·5
Anhydrous fibre per cent. megass ..	47·0

On the other hand, it will be evident that we have :—

Weight of canes worked=weight of dilute juice plus weight of megass minus weight of water added.

Now, the weight of dilute juice is :—(1)*

$$249423{\cdot}38\times1{\cdot}0726=267531{\cdot}51 \text{ kilos.}$$

The weight of water added :—

$$23060{\cdot}02\times0{\cdot}995=22967{\cdot}77 \text{ kilos.}$$

As regards the weight of megass, it is found by the following calculation :—

47 of fibre correspond to 100 of megass

11·26 ,, ,, ,, $\dfrac{100\times11{\cdot}26}{47}=23{\cdot}95.$

Then 100 of cane correspond to 23·95 of megass, and x of cane to $\dfrac{23{\cdot}95\times x}{100}$, x being the required weight of canes crushed.

We therefore have:—

$$x=267531{\cdot}51+0{\cdot}2395x-22967{\cdot}7$$

$$\text{and } x=\frac{267531{\cdot}51-22967{\cdot}7}{0{\cdot}7605}=321582{\cdot}82 \text{ kilos.}$$

This weight being found, the extraction by the mill becomes :—

* 1. In cases where the sulphitation juice alone is measured, the volume of the dilute juice may be accurately calculated as follows:—

Sucrose in sulphitation juice = 254609·66 × 0·1618 = 41196·87. As the difference in Glucose coefficient between the dilute juice and that of the sulphitation juice is 1·3, there is inverted 1·3 × 0·95 = 1·23 per cent. sucrose.

Therefore, sugar inverted $=\dfrac{41196{\cdot}87}{100}\times1{\cdot}23=506{\cdot}72.$

The sucrose in the diluted juice would therefore be:

$$41196{\cdot}87+506{\cdot}72=41703{\cdot}59.$$

Now, as the dilute juice contains 16·72 sucrose, the volume should be:

$$\frac{41703{\cdot}59}{0{\cdot}1672}=249423{\cdot}38 \text{ kilos.}$$

Weight of dilute juice minus weight of water added, divided by the weight of canes $= 76 \cdot 05$, on substituting the values.

Certain chemists, after having found 23·95 of megass per 100 of cane, calculate the extraction by deducting this figure from 100. $100 - 23 \cdot 95 = 76 \cdot 05$. It is therefore seen that by first calculating the actual weight of canes crushed, the extraction is found by deducting the whole of the maceration water from the total weight of the diluted juice, as we proposed in 1901.

Let us now see what quantity of juice is present in the cane, and what remains in the megass.

Juice in the cane $= 100 -$ hydrated fibre. Assuming that the fibre exists in the hydrated state, corresponding to the formula $(C_{12}H_{22}O_{11})^n$ we have

C_{12}	144
H_{22}	22
O_{11}	176
	342

Which is equivalent to 324 of anhydrous cellulose $(C_{12}H_{20}O_{10})^n$. 11·26 of anhydrous cellulose per 100 of cane therefore correspond to 11·88 of hydrated cellulose, from which we find that the juice originally present in the cane is equal to $100 - 11 \cdot 88 = 88 \cdot 12$, and that the juice which remains in the megass is equal to $88 \cdot 12 - 76 \cdot 05 = 12 \cdot 07$.

On the other hand, an analysis of the megass gave the following results:—

	Water	45·5
	Anhydrous cellulose	47·0
	Sucrose, &c.	7·5
		100·0
Or,	Water	42·9
	Hydrated cellulose	49·6
	Sucrose, &c.	7·5
		100·0

From the above analytical data we may now express the composition of 23·95 parts of megass as follows:—

Hydrated fibre	11·88	
Water	10·27	$\left.\right\} = 12 \cdot 07$ of juice.
Sucrose, &c.	1·80	
	23·95	

That is to say, exactly the quantity of juice which should be present when the extraction is based on the weight of juice originally contained in the cane.

In this result we have a proof that the megass does not retain any water added to the mill for maceration, under the condition that the moisture of the megass is carefully regulated and maintained within the usual limits of from 45 to 47 per cent., by suitable adjustment of the rollers; a condition we have repeatedly laid stress on.

Now in the discussions with our critics, who calculate the extraction by milling from the apparent weight of the canes and who admit that a part of the maceration water is retained by the megass, we have never been able to substitute their weight of megass, per 100 parts of cane, when starting from the composition of the megass, as determined by them, which they are unable to account for.

We think we may now assert that the megass does not retain any maceration water when its moisture is normal, or, at most, only an inappreciable quantity.

We pass to the saccharine richness of the cane, which is equal to:

$$\frac{\text{Sucrose in the dilute juice} + \text{Sucrose in the megass}}{\text{Weight of Canes.}} \times 100$$

$$= \frac{(249423{\cdot}38 \times 0{\cdot}1672 + 321582{\cdot}82 \times 0{\cdot}2395 \times 0{\cdot}053) \times 100}{321582{\cdot}82} =$$

$$= 14{\cdot}237.$$

If, instead of the weight of canes actually crushed, we take the weight of canes when purchased, we find a saccharine richness of 13·097 instead of 14·237; a result which could not be obtained from canes yielding a first mill juice with 18·6 per cent. sucrose, and a density of 8·11.

This determination of saccharine richness is another proof that the calculated weight of canes is correct. Moreover, if we consult the analyses of canes made by different chemists, we always find that a first mill juice, having the composition of our example, corresponds always to a saccharine richness in the cane exceeding, not 13, but 14 per cent.

Blyth Bros. & Co., Mauritius, report shipments of sugar from August 1st to September 10th, 1904, at 8,811 tons, as compared with 21,725 tons during the same period of 1903.

DIFFUSION BY CONTINUOUS AND FORCED CIRCULATION.

(Naudet System.)

By M. L. Naudet.

(From *Bulletin de l'Association des Chimistes.*)

Every fabricant has heard something about the results obtained during the last campaign by my process of diffusion by forced circulation. Much has been done towards perfecting this process at the usines of:—Maing (North France), under M. Bernard; Neuilly-Saint-Front, owned by the Société des Sucreries de Fives-Lille; la Roche, at Gand, Belgium; Moerbeke, Belgium; and Azucarera Labradora, at Calatayud, Spain; not to mention others.

In each case the juices were clear and limpid, differing entirely from ordinary diffusion juices, and easily worked at the different stages of manufacture, the co-efficient of purity being increased, on this account, by at least 25 or 30%. The first and second carbonatation juices were also of excellent quality, and quite beyond comparison with those of the same density obtained by the usual method. The syrups were limpid, clear, almost colourless, easily worked up in the pan, and yielded molasses which could be filtered without difficulty. In addition to these recognised advantages, the process affects a considerable economy in fuel, this being due to two causes. First, the diffusion juices were heated by the vapour from the first vessel of a triple effet, the second of a quadruple, or even the third vessel of a quintuple effet; and, secondly, the juices, worked up in the usine, had a density corresponding to 85% of that of the normal beet-juice.

This economy is effected without great expense, it being unnecessary to increase the heating surfaces of the battery-heaters in order to utilise vapour from the first vessel of a quadruple or quintuple effet, which alteration is generally necessitated by the distance such vapours have to be conveyed. But, on the contrary, this is effected at small cost by passing the diffusion juice through the requisite number of re-heaters situated close to the evaporating apparatus, and requiring no special supervision.

The battery work is extremely simple. The circulation of the juices round the battery is not interfered with by the forced circulation through the individual diffusers. The juice is drawn off from the battery at a constant level, the motions of the juice in each diffuser being similar for each operation. There are no concussions caused by the sudden rupture of the column of liquid owing to the alternating speed in the flow of liquid; rapid during "meichage"* and slow during the drawing-off of juice.

* The term "meichage" has no English equivalent, but refers to the introduction of rich diffusion-juice to the terminal diffuser, which has been charged with fresh beet-slices.

The working of the battery is decidedly superior in all these points, and, during the past campaign, we have only met with one slight inconvenience—we worked too rapidly to allow the battery to be under proper control. The juices moved freely without loss in saccharine richness; no accumulation of gases at the top of the diffusers impeded their working; there was no fermentation, because the slices were instantly sterilized in the terminal diffuser; the diffusion was so rapid that the battery operations had to be occasionally stopped, the juice not being evaporated as rapidly as it could be drawn from the battery. Some small inconveniences were therefore experienced. When the battery is stopped it does no work, although it is true that diffusion proceeds during a stoppage of, say, one minute, until equilibrium is established on both sides of the cellular membranes of the beet-cells; but, if the period of contact be prolonged, the salts continue to diffuse to the detriment of the purity of the juice. Consequently, having numerous stoppages of from fifteen to twenty minutes each, amounting to a total of from two to three hours per day, time was not only lost, but the purity of the juices were unfavourably affected.

A more serious result of such stoppages was that the circulating pump had not a free delivery-outlet so that the pressure in the circulating main rose to a maximum of from two to three atmospheres. If, then, a valve was imperfectly closed, owing to a fragment of beet slice or other obstruction being interposed between the valve and its seat, the juice leaked into the exhausted diffusers so that after each stoppage, the extraction was less perfect than when the work was in full swing. I admit that, in the event of a stoppage, it is only necessary to stop the pump but this calls for the special attention of the workmen who will not trouble to stop the pump engine, believing the stoppage to be only momentary. This need not apply when the pump is driven by an electric motor, requiring merely the handling of a switch, but, as all usines have not this convenience, this point is worth considering.

As stated, we have only met with this single inconvenience which we have successfully remedied by arranging that every diffuser is in operation for a similar period of time, which is regulated by the head battery man without demanding any attention on the part of his assistants.

To-day, this process is complete in every detail and offers many well recognised advantages, permitting, moreover, a determined quantity of work to be completed each day, and which can be immediately and exactly controlled at will, in order to meet the requirements of the factory.

We herewith describe our process for the benefit of all who have requested information on the subject, also its special applications as under:—

1. For extracting hot juices in the Sucrerie.
2. ,, ,, cold ,, ,, Distillery.
3. For operating two batteries simultaneously.

the operations being similar in all three cases and based on the same principles.

DESCRIPTION OF THE PROCESS.

From investigations on diffusion prior to 1900 it is well known that the rapidity with which the juice is heated materially assists the diffusion, increasing the density of the juices and the degree of exhaustion of the cossettes. For a long time we were satisfied with drawing off 120, or more, litres per 100 kilos of roots worked, and, recollecting how a battery was then heated, we obtained the following temperatures in successive diffusers:—

30, 45, 60, 75, 80, 80, 80, 75, &c.

In other words, the heating was graduated so that the maximum temperature was not reached until the fourth or fifth diffuser of the battery.

At that time, the juice-heaters were constructed with very small heating surfaces, which did not allow the juice to be rapidly heated to the maximum temperature. This defect was early recognised by investigators, one of whom, if not the first, was our distinguished colleague, M. Henri Pellet. Larger heating surfaces were adopted for heating the juice undergoing "meichage," and also for rapidly raising the temperature of the juice passing from one diffuser to another. The object was not, however, achieved satisfactorily, although juices of higher density were obtained, and the volume drawn off reduced to 105 or 110 litres. Others, amongst whom were Melichar in Austria, and F. Garez in France, tried the effect of passing the juice intended for "meichage" through re-heaters, so as to conduct this operation at the highest possible temperature; but this did not get over the practical difficulty of rapidly raising to its maximum the temperature of the juice entering the meichage diffuser from the one preceding it. The most important diffuser, namely, that which gives the juice its intensity and purity, had not, therefore, the temperature most favourable to diffusion. Working thus, we could not, except in certain cases, exceed a temperature of 80 without risk of gelatinizing the slices, and promoting fermentation by retarding the work, the gradually heated beet-slices not being able to bear a temperature as high as from 90 to 92 in the interior of the diffuser, which they might withstand without injury, when rapidly circulated under such conditions that this high temperature is not maintained in the diffuser for any length of time.

This is the condition I sought for, viz., to rapidly raise the temperature of the slices to the maximum, without exceeding the limit at

which they gelatinize, by introducing the juice into the terminal diffuser at its maximum temperature, thus avoiding the gradual heating necessitated by the usual method of working. To attain this object it is necessary to return the more or less cooled juice, after heating same, to the top of the terminal or "meichage" diffuser, and as is well known, I effect this by means of a pump connected with suction and delivery pipe-mains. Last year, I succeeded in dispensing with the suction-main, adding, however, a "compensator," the object of which will shortly be evident. By this arrangement, I have perfected a battery possessing exceptional adaptability, answering all the requirements of my investigations, and which has been operated during the entire campaign, with most satisfactory results, in ten or more usines.

This I proceed to describe, indicating, at the same time, the methods to be followed to obtain the principal advantage mentioned above—namely, the exact and instantaneous regulation of the working period of each diffuser under the control of the battery superintendent. The whole process depends upon the rôle of the compensator, which may therefore be first referred to.

The Compensator.

I have elsewhere shown that if hot juice be introduced at the top of a diffuser filled with juice and fresh slices, if p is the weight of slices contained in the diffuser, then, in order that this weight (p) may be uniformly heated to the temperature of the entering juice, the latter must have the following weight:—

$$P^1 = 3\ p.$$

It is therefore theoretically necessary, for the success of my process, to introduce at the top of the diffuser, immediately after "meichage," a volume of juice equal to the three times the weight of the slices contained in that diffuser, and this operation must necessarily be completed during the time that a volume (v) is drawn off from the preceding diffuser and a volume (v^1) for the "meichage."

If we admit, as is approximately true, that the weights are proportional to the volumes, it follows that three volumes (v) should pass out of the diffuser under circulation during the time that two volumes ($v\ v^1$) escape from the preceding diffuser. We may therefore state

that $\quad v^1 = V$

and that $v \ = V + x$

x being the excess of juice drawn off over that used in "meichage," and $x = 0$ if 100 litres of juice are drawn from diffusers containing 54 kilos of slices per hectolitre.

It is true that there are variations in the manner of charging the diffusers, but in proportion as this is more perfect my explanations will be the more accurate.

Under the above conditions, three volumes of juice must enter the diffuser for every two volumes passing out of the battery, and it is evident that, in order to attain this velocity, the pump must produce such a pressure as will tend to drive the slices into the perforations in the bottom plates of the diffusers, and, occasionally, through the same, like fish escaping through the meshes of a net; thus reducing the perforated area, hindering the circulation, and retarding the work of the battery.

If the suction of the pump be directly applied to the bottom of the diffuser the same phenomena occurs, but with even more disastrous results. This rapid and forced circulation through the diffuser can, however, be maintained without this inconvenience, and the apparatus employed I therefore call the "compensator."

This consists of a closed tank having approximately the same capacity as the diffuser but of relatively large diameter. It is erected in a suitable position on the battery-platform in such a manner that the lowest level of the contained juice may be just above the floor of the platform. We may next proceed to describe its action.

When certain valves are opened, the pump draws the juice directly from this tank, into which juice enters from the diffuser in such a manner that the increased volume of juice in the compensator exerts an upward counter-pressure through the bottom of the diffuser, preventing the slices from adhering to the perforated plate or passing through it. In practice it is found that this counter-pressure, and the working-speed of the battery, increase in proportion as the compensator is filled, thus proving that its action is as stated. This is the secret of operating the battery at its maximum speed, and, when once this was attained, the other inconveniences met with last year disappeared or were more or less counteracted.

The compensator also serves to equalise the temperatures. On referring to the pages of the *Bulletin*, it will be found that when the "meichage" was conducted with juice at 80° and juice at 80° also returned to the top of the diffuser during circulation, the following temperatures occurred :—

79, 78, 76, 72, 68, 64, 58, 52, 45, 39, 33, 29, 26, 28, 31,
36, 42, 48, 53, 58, 62, 66, 70, 72, 74, 76, 77, 78, 79.

If these juices are returned to the diffuser through a heater at the same speed as they are drawn away by the pump, it will be impossible for these juices to collect in my compensator, into which there simultaneously pass the two volumes of juice at 80°, namely, that to be drawn off and that required for "meichage." These five volumes intermix, yielding a mixture of approximately uniform temperature, and no longer varying from 25° to 80°, but barely from 4° to 5°.

Pump, Re-heaters, Valves, and Pipe-mains.

A centrifugal pump should be employed which does not agitate the juice with the production of foam; we specially recommend the Schabaver Pump, which gives the required pressure and works smoothly. We have known these pumps to have given entire satisfaction during three campaigns, and they are perfectly adapted to the necessary variations in the work of a sucrerie.

We employ re-heaters, the tubes of which have a sectional area of $1\frac{1}{2}$ times that of the circulating main piping. According to their size, the juice should be deflected six or eight times, the speed of flow of the juice through the tubes being at least 1·7 metres. Such apparatus, heated by steam at 100, should have a total heating surface corresponding to 0·20 square metres per ton of roots worked per day. We do not advise the use of high pressure steam which causes the temperature of the circulated juice to be much more irregular.

No special pipe-mains are required except those connecting the re-heaters to the diffusers, with a branch and valve on each diffuser. It is unnecessary and even objectionable to employ large valves; those of 100 are preferable for diffusers of from 40 to 50 hectolitres capacity. They close more easily than larger valves and there is less risk of leakages in the event of a stoppage. Several stop-valves, of the same diameter as those already mentioned, complete the description of the special apparatus required.

We may state that the adoption of the process would be much less costly in such usines as are already equipped with re-heaters, as all should be which are adopting modern methods.

(To be continued.)

ON THE WEIGHT OF SUGAR PRODUCED PER HECTARE OF BEET OR CANE.

We have no intention of taking part in the present discussion between Messrs. Aulard and E. Saillard on the very important question: Which species of beet should be cultivated?

We merely wish to draw attention to some of our investigations with regard to the quantity of sugar which can be produced per hectare of soil.

All are acquainted with the studies of Messrs. Champion and Pellet on the quantity of mineral matter necessary for the formation of 100 kg. of sugar; we have, moreover, shown that the quantity of matter absorbed by the beet was directly proportional not only to the weight of crop harvested, but to the total quantity of sugar obtained.

In a word, for 100 kg. of sugar formed in poor beets, there exists in the whole beet (root and leaves) as much mineral matter as in the case of 100 kg. of sugar formed from rich beets.

It was however shown by our tests that in the rich beet, the quantity of foliage was greater and its composition different; the mineral matter was in much greater proportion in the green foliage than in the root, whereas the poor beet having less foliage containing less mineral constituents, its root remains rich in mineral matter.

It is owing to this that it has been truly said that the rich beet exhausts the soil less than the poor beet, and this has been verified practically since the rich beet has been cultivated in France, about 20 years ago.

If then, for a given quantity of sugar, the soil is required to furnish a determined weight of mineral constituents, one can deduce *à priori* that, the soil remaining unchanged, each hectare will always produce the same quantity of sugar, whatever be the richness of the beet harvested.

This point has long been known, and we have referred to it in various reports when the question arose in connection with the increased duties on sugar brought about by the legislation of 1884.

A large number of tables have been compiled to bring out the advantages of the rich beet from different points of view and they take as a basis *the same quantity of sugar to the hectare* produced from beets of 9-10-11% and of beets of 13-14-15 and 16%.

But this principle had been known even before our studies, for Dubrunfaut, Stammer and others had distinctly declared that the "richness of the beets appeared to be in inverse proportion to the weight of the crop."

We might mention besides that M. Pagnoul, the Director of the Sta. Agronomique of Pas-de-Calais, has been able to confirm this view by practical experiments.

We were therefore not astonished to find, in the note of M. Saillard, very interesting information which goes to confirm our conclusions.

Taking the yields obtained at Genappe drawn up by M. Aulard, from 1892 to 1896, a yield in weight of 33,480 kg. with 12·83% sugar, gives 4,296 kg. of sugar to the hectare. From 1897 to 1903, 29,600 kg. of beets with 14·43% sugar, gives 4,271 kg. of sugar to the hectare. These figures are entirely similar, and are of great value because they correspond to a period of several campaigns, and moreover are obtained from the same district.

Further on, in referring to "rich" and "medium" beets, M. Saillard gives the following figures:—

1. According to the results obtained by M. Tribondeau, Departmental Professor of Agriculture (Pas-de-Calais), the quantity of sugar produced per hectare between "rich" and "medium" varieties does not differ by more than 200 kg.

2. M. Duclough, in the North, has given 34,000 kg. of beets at 7·40 density and 57,700 at 4·8 density.

These yielded an almost identical total of 5,000 to 5,100 kg. of sugar per hectare.

This result has, moreover, been obtained by many experimenters within the last few years, since methods of analysis have allowed the easy estimation of the sugar; it is particularly the case in Belgium, where the beets are bought by their percentage of sugar, and not by their density. Consequently it is almost certain that the quantity of sugar per hectare that can be obtained on an average in a beet district cannot vary much, whatever be the richness of the beets harvested.

This is true for Belgium, France, and the majority of sugar countries, especially within the last few years.

In France, for example, we had previous to 1884 yields per hectare varying from 40,000 to 70,000 kg., but having only 11-7% sugar, when now we can reckon 30,000 to 32,000 kg. with 13-15% sugar.

Does this amount to saying that we cannot increase the quantity of sugar to the hectare, which at present appears to be in France 4,200 to 4,500 kg.? Evidently not.

It is true that the quantity of sugar per hectare, employing the same seed and the same methods of cultivation, varies with the year according to the climatic conditions, but in the mean for a period of 2, 3, or 4 years, figures are always obtained which approximate those cited above. Yet if the mean yield of sugar per hectare is from 4,200 to 4,500 kg. in France, there are appreciable variations between these extremes.

Certain cultivators obtain only 3,500 kg., while others obtain five or six thousand kg. of sugar to the hectare. All depends on the soil, the methods of cultivation, manuring, &c., which go to influence the amount of mineral matter and nitrogen present in the soil during the period of vegetation. Then nothing prevents the supposed production of a rich beetroot furnishing a harvest of 50,000 to 60,000 kg. per hectare.

In the trials we undertook on the beet farm at Wanze we were enabled to show that the quantity of 7,000 kg. of sugar per hectare could be obtained in practice by choosing a seed suited to the particular soil, and by following the principles of rational culture as regards the preparation of the soil, the distribution and the composition of the manures, &c. One has equally verified results much above the average in the case of contractors to the sucrerie.

Similarly in Germany during certain years from 1871 to 1886 the mean crop did not reach 25 to 26,000 kg. according to Dureau, with

a beet of 12 to 13% sugar; whereas now the mean is nearer 30,000 kg. with a richness of 14 to 16%.

One can hence increase the quantity of sugar per hectare to an enormous extent by considering the quality of the seed and the method of cultivation. But it is certain that the quality of the soil is a very important factor when one wishes to exceed the average crop. In this connection we quote a striking example.

In 1884 we visited a German sucrerie which worked up beets on the 19th January having 13·38 kg. of sugar. The sugar manufacturer was not satisfied with the mean yield of the campaign, which was about 10·50 kg. (total sugars) without employing any processes of extracting sugar from the molasses.

Some years previously we had visited the same factory which had then a yield of only 9·2 or 9·3% all sugars. But in 1890-91, in the same factory, the richness of the beets was so great that the yield of the first sugar (German standard) was 15·1 and the total yield 17·2%.

To obtain such a result, the beets worked up during the entire campaign must have contained almost 19·5 or 20% of sugar, and this was obtained in practice in working, we believe, 35 to 40 thousand metric tons. We have been able to satisfy ourselves that this factory dealt with roots having 22·23% of sugar, but is situated in a district where the soil is remarkably favourable for beet cultivation. So much so, that we have analysed beets raised from seed considered nowadays a poor sugar producer, which yielded 13 to 14% of sugar with a mean weight of 8 or 900 grammes, whereas the same seeds, in France, only furnished 10 to 11% of sugar with a like weight of root. The influence of the soil was very striking, and the manufacturer had been able to profit by it—to evolve, by continuous selection, a suitable seed which furnished in practice seven to eight thousand kg. of raw sugar per hectare. But these are clearly exceptional figures for the beet.

But it is none the less true that the quantity of sugar produced per hectare can be increased by placing at the disposal of the crop the requisite mineral and nitrogenous elements capable of yielding a quantity of sugar greatly exceeding the usual average, whether in the form of a crop of rich or of poor roots, as may be desired.

This has been done for the sugar cane in certain countries, where the quantity of sugar produced per hectare, formerly from 6 to 8,000 kilos, has reached 10, 12, and even 14,000 kilos per hectare in exceptionally favourable years. To sum up:—

1. The average quantity of sugar produced per hectare from the beet has, for many years, been between 4,300 and 4,500 kilos.

2. This quantity varies little whatever be the richness of the roots harvested.

3. The yield in weight per hectare should consequently be in inverse proportion to the richness of the roots.

4. It is possible to increase the quantity of sugar per hectare by supplying the root with mineral and nitrogenous matters in suitable proportions, whether rich or poor roots be desired.

5. The quantity of mineral matter needed to form 100 kg. of sugar lies invariably between 13 and 14 kg.

6. The maximum quantity of sugar per hectare produced in practice during any single campaign, appears to be at least 7,000 kg. in the case of one factory.

7. In special cases it has been possible to obtain almost 8,000 kg.

8. The quantities of sugar obtainable per hectare from the sugar cane are also very variable, but at the present day, if, from some lands the crop is not more than 6,000 kg. to the hectare, 10 or 12,000 kg. may be reached in other places, where the agriculturists and sugar manufacturers have constantly endeavoured to improve the quality of the cane and the yield in weight.—*(Journal des Fabricants de Sucre.)*

CONSULAR REPORTS.

Austria-Hungary.

Bohemia.—There were 8,940,000 tons of beetroot worked during the campaign of 1901-02 in Austria-Hungary, as against 7,130,000 tons in that of 1902-03. In Bohemia there were worked 4,190,000 tons and 2,860,000 tons of beetroot during these periods respectively.

The production of Austria-Hungary was:—

Year.	Quantity. Tons.	Number of Mills.
1901-1902	1,291,127	216
1902-1903	1,051,264	216

The production of sugar in Bohemia was:—

Year.	Quantity. Tons.	Number of Mills.
1901-02	658,285	128
1902-03	440,225	127

The total export from Austria-Hungary was:—

	Quantity. 1901-02. Tons.	1902-03. Tons.
Raw sugar	33,985	108,505
Refined ,,	704,801	639,509
Equivalent in raw sugar	817,098	819,070

The total export from Bohemia was:—

	Quantity. 1901-02. Tons.	1902-03. Tons.
Raw sugar	9,630	15,214
Refined ,,	389,611	374,717
Equivalent in raw sugar	442,531	431,566

The sugar exported in 1903 to the United Kingdom from Austria, exclusive of Hungary, was:—

	Quantity. Tons.
Raw sugar	21,684
Refined "	282,763
To India—Raw sugar	20
Refined "	5,008

The additional duty on sugar imported into India being now removed, combined with the very cheap sea freights now ruling, a great impetus has been given to this trade. The exports to India for the first three months were:—

Year.	Quantity. Tons.	Value. Rupees.
1903	1,529	149,953
1904	28,776	2,715,442

The percentage of sugar contained in the beet during the 1902-03 campaign for Austria was 14·8; the percentage for Bohemia alone was 15·3, as against 14·5 and 15·8 per cent. for the previous year respectively.

There were 284,024 tons of molasses produced in Austria-Hungary in 1902-03, of which 117,663 tons were produced in Bohemia. There were 49 tons exported, and 209,261 tons were used for the production of spirits:—

Year.	Value. Imports. £	Value. Exports. £
1900	70,682,000	80,917,000
1901	68,860,000	78,561,000
1902	71,824,000	79,688,000
1903	77,993,000	88,005,000

Bosnia.—The British Consul states:—The sugar factory in Usora seems to have done no better in 1903 than heretofore. The culture of the beet, owing to the great care it requires, does not seem to find favour with the native population, and I understand that the present proprietors of the factory are anxious to part with it. About 5,000 tons of sugar were produced last year, of which 4,000 tons were consumed in the province and the remainder exported to Dalmatia.

The alcohol distillery of Messrs. Fischl & Sons in Tuzla continues to thrive. Of the 220,000 gallons produced in 1903 176,000 gallons were sold in the province and the remaining 44,000 gallons exported.

BELGIUM.

The decline noted in the sugar exports of 1902 continued during 1903, and the total exports fell from 134,394 tons in 1902 to 116,655 tons in 1903, this latter quantity being exactly half the amount of the volume exported in 1901.

The imports remained practically at the same level.

Portugal.

Angola.—The bounties on sugar granted by the Portuguese Government have induced some cane planters, who have hitherto confined their attention to rum, to lay down machinery for the manufacture of sugar for export to Portugal. This machinery is American and French. Some 347 tons of sugar were imported during 1903 and 171 tons exported.

Madeira.—The British Consul reports:—The cane crop of 1903 was exceptionally short, owing to want of rain at the proper season, and also to a fungoid disease which attacked all qualities of cane about one month before reaching maturity. The only exception is the "Yuba" cane, which has up to the present resisted the disease, and there is no doubt whatever that in two or three years' time this cane will be universally grown in the island.

The entire cane crop of Madeira was roughly estimated at 19,000 tons, valued at £56,000, of which 6,000 tons were converted into sugar and the remainder into cane spirit for local consumption. It is early yet to say what the result will be of the seedling canes imported from Barbados, but at present they do not appear very flourishing.

All the cane turned into sugar was manufactured by the Hinton-Naudet process, an improvement on the Naudet process, and the results were remarkable. During the 1903 season all the juice or saccharine matter was extracted from the cane with a loss of ·36 per cent. of the total sugar contained in the cane, and this juice was obtained in nine-tenths of its original density. This process has made quite a sensation in the sugar world, and during 1904 season, which is just over, planters from Trinidad, Demerara and Réunion came to Madeira to inspect it.

China.

State of imports of sugar:—

	Average. 1898-1902. Cwts.	1902. Cwts.	1903. Cwts.
Brown sugar	1,351,976	2,663,398	1,474,647
Candy ,,	58,638	162,420	215,091
Refined ,,	1,009,713	1,639,563	1,355,015
White ,,	463,215	862,245	768,318
Total	1,883,542	5,327,626	3,813,071

The import of sugar fell off by about 1,500,000 cwts., brown sugar having reverted to the position it occupied in 1901. The decline is attributed to an impaired spending capacity on the part of the consumer, and, under the circumstances, one might have expected that exports from Swatow, which are on a silver basis, would have revived. So far from this being the case, Swatow exported 192,170 cwts. less in 1903 than in 1902.

Canton.—Imports from foreign countries into Canton :—

	Average 5 years. 1898-1902. Cwts.	1902. Cwts.	1903. Cwts.
Brown sugar	3,969	8,378	14,730
White ,,	50,285	139,871	185,077
Refined ,,	31,649	56,711	39,275
Candy ,,	2,958	2,702	6,744

	Exports.		
	1898-1902. Cwts.	1902. Cwts.	1903. Cwts.
Brown sugar	178,218	148,214	67,936
Cane ,,	21,607	33,101	58,485

Japan.

Nagasaki.—The trade in imported refined sugars from Hong-Kong is rapidly falling off, owing to the increased production of refineries in Japan. It seems as if the entire business would shortly be absorbed by the Japanese, and, there being no refineries in this district, all the raw material intended for refineries goes to other ports.

The import of Hong-Kong sugar to Nagasaki in 1903, which was for local consumption only, amounted to 29,200 cwts., with a value of £20,477. These figures show a decrease from the import of 1902 of 48,964 cwts. and of £24,463 in value.

The import of sugar to this port was classified in the customs returns as follows :—

Class I.—Raw sugar or sugar partially refined up to and inclusive of No. 14 Dutch standard in colour :—

From.	Quantity. Cwts.	Value. £.
China	3,235	1,290
Hong-Kong	1,351	712
Philippines	8,148	4,024

Class II.—Refined sugar Nos. 15 to 20 Dutch colour standard :—

From.	Quantity. Cwts.	Value. £.
Hong-Kong	6,933	3,790

Class III.—Refined sugar above No. 20 Dutch standard in colour :—

From.	Quantity. Cwts.	Value. £.
Hong-Kong	20,931	15,976
Russia	250	139

From the above figures it appears that, as far as Nagasaki is concerned, the sugar trade as it exists at present is of not much importance to British mercantile interests.

Siam.

Bangkok.—Sugar to the value of £138,507 was imported into Bangkok during 1903. Most of it came from Singapore, Hong-Kong and China taking the second place.

BRAZIL.

Bahia.—The sugar exported from Bahia during 1903 amounted to 7,695 tons and was valued at £130,971.

MEXICO.

Some 774 tons of sugar, chiefly from Germany and the United States, were imported into Mexico during 1902.

PERU.

The crop of sugar of 1903 was good, but prices were scarcely remunerative. The lowest local quotation during the year was 6s. and the highest 8s. per quintal of 100 lbs. It is estimated that the total production of this staple article was about 150,000 tons, of which 125,662 tons were exported. At present the best market for Peruvian sugar is Chile, to which country 54,524 tons were exported in 1903.

PUBLICATIONS RECEIVED.

"LISTE GÉNERALE DES FABRIQUES DE SUCRE," 1904-05.

This hardy annual, issuing from the office of the *Journal des Fabricants de Sucre*, needs no special commendation, as it has so often been referred to in our pages. This year's number is replete with the usual information about sugar factories and refineries, local laws and institutions, &c. We note, however, one or two errors on the pages dealing with Great Britain; several of the British refineries now at work are given as "inactive."

"ZUCKERINDUSTRIE-KALENDER," 1904-05. Two parts. Compiled by Dr. W. Krüger. Leipzig: Eisenschmidt & Schulze.

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. THOMPSON, C.E., F.C.S., M.I.M.E., Chartered Patent Agent, 6, Lord Street, Liverpool; and 322, High Holborn, London.

ENGLISH.—ABRIDGMENTS.

19645. E. MOTI, Italy. *Improvements relating to the treatment of wine, must, beer, beetroot juice and the like, and to apparatus therefore.* 11th September, 1903. This invention relates to a method for the concentration of wine, must, beer, beetroot juice, and of any other alcoholic or sugared liquid in general by means of freezing followed by fractional liquation and displacement of the useful matters from the ice formed, and apparatus relating thereto.

26779. J. C. F. LAFEUILLE, Paris, France. *Improvements in and in connection with annular moulds for treating sugar by centrifugal action.* 7th December, 1903. This invention consists in effecting the cooling of the annular moulds serving for the moulding and the subjecting to centrifugal action of sugar slabs or loaves, by causing liquids of different temperatures to circulate consecutively through the annular mould, and round the separate moulds for slabs or loaves therein, so as to cool these by means of liquids of gradually decreasing temperature the said annular moulds, being provided with means for connecting them consecutively to supplies of liquid at different temperatures, and for discharging such liquids.

28572. H. H. LAKE, London. (Communicated by E. N. Trump, Syracuse, County of Onondaga, State of New York, United States of America, Mechanical Engineer.) *Improvements in the process of evaporating liquors.* 29th December, 1903. This invention relates to improvements in the process of evaporating liquors, and is especially useful in connection with the evaporation of liquors in which crystals form. The object of the new process is to enable liquor to be evaporated under vacuum pressure but so that the crystals which form in such liquor shall not be allowed to settle and become caked.

GERMAN.—ABRIDGMENT.

153856. CARL STEFFEN, of Vienna. (Patent of addition to Patent No. 149593, of 15th February, 1901.) *A pressing process for obtaining pure concentrated expressed beetroot juice and residues rich in sugar.* May 12th, 1901. The warm juice which, according to the principal patent, passes over the fresh beetroot paste or shreddings for the purpose of acting thereon, is, before being used, somewhat evaporated or concentrated in suitable vessels, so that its concentration is increased beyond the normal concentration of the expressed juice of the disintegrated roots employed.

IMPORTS AND EXPORTS OF SUGAR (UNITED KINGDOM)

To end of September, 1903 and 1904.

IMPORTS.

Raw Sugars.	Quantities. 1903. Cwts.	Quantities. 1904. Cwts.	Values. 1903. £	Values. 1904. £
Germany	3,707,895	4,752,046	1,545,138	2,146,973
Holland	170,559	227,412	65,364	111,978
Belgium	626,217	348,867	260,631	160,199
France	517,392	437,832	226,731	227,008
Austria-Hungary	1,521,912	683,432	636,623	307,428
Java	318,373	1,431,822	154,532	636,742
Philippine Islands	70,646	86,650	25,285	31,025
Cuba	444,206	....	215,443	....
Peru	277,978	839,506	114,163	391,730
Brazil	67,156	82,317	26,219	31,176
Argentine Republic	409,672	....	184,709	....
Mauritius	264,040	495,351	94,226	186,011
British East Indies	259,325	189,821	95,043	76,756
Br. W. Indies, Guiana, &c.	556,309	824,521	335,089	533,439
Other Countries	443,102	419,849	193,390	194,449
Total Raw Sugars	9,654,782	10,819,426	4,172,586	5,034,914
Refined Sugars.				
Germany	11,909,197	8,270,042	6,223,594	4,690,425
Holland	1,677,692	2,370,350	974,266	1,422,314
Belgium	100,572	367,751	58,952	212,967
France	684,872	2,105,017	387,544	1,185,416
Other Countries	864,470	171,945	428,140	91,035
Total Refined Sugars	15,236,803	13,285,105	8,072,496	7,602,157
Molasses	1,145,978	1,336,620	210,300	245,177
Total Imports	26,037,563	25,441,151	12,455,382	12,882,248

EXPORTS.

British Refined Sugars.	Cwts.	Cwts.	£	£
Sweden and Norway	19,914	25,853	10,482	13,806
Denmark	73,630	86,282	40,055	44,037
Holland	49,675	47,834	26,785	25,752
Belgium	6,820	8,876	3,453	4,827
Portugal, Azores, &c.	5,972	12,944	3,271	6,975
Italy	6,772	3,238	3,100	1,515
Other Countries	531,432	259,988	323,987	168,439
	694,215	445,015	411,133	265,351
Foreign & Colonial Sugars.				
Refined and Candy	33,907	19,992	20,805	13,805
Unrefined	48,471	91,260	25,351	50,434
Molasses	1,411	1,835	690	1,022
Total Exports	778,004	558,102	457,979	330,612

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1904. Tons.		1903. Tons.
Total Receipts, Jan. 1st to Oct. 13th ..	1,595,878	..	1,374,037
Receipts of Refined ,, ,, ,, ..	564	..	1,264
Deliveries ,, ,, ,, ..	1,597,246	..	1,340,417
Consumption (4 Ports, Exports deducted) since 1st January	1,500,722	..	1,380,819
Importers' Stocks (4 Ports) Oct. 12th ..	10,793	..	36,005
Total Stocks, Oct. 26th.	159,000	..	129,342
Stocks in Cuba, Oct. ,, ...	6,000	..	126,011
	1903.		1902.
Total Consumption for twelve months ..	2,549,643	..	2,566,108

CUBA.

STATEMENT OF EXPORTS AND STOCKS OF SUGAR, 1903 AND 1904.

(Tons of 2,240lbs.)	1903. Tons.		1904. Tons.
Exports	826,108	..	1,078,906
Stocks	158,593	..	16,916
	984,701	..	1,095,822
Local Consumption (nine months)	30,720	..	32,721
	1,015,421	..	1,128,543
Stock on 1st January (old crop)	42,530	..	94,835
Receipts at Ports up to September 30th ..	972,891	..	1,033,708

Havana, 30th September, 1904.

J. GUMA.—F. MEJER.

UNITED KINGDOM.

STATEMENT OF IMPORTS, EXPORTS, AND CONSUMPTION FOR NINE MONTHS ENDING SEPTEMBER 30TH.

SUGAR.	Imports. 1902. Tons.		Imports. 1903. Tons.		Imports. 1904. Tons.	Exports (Foreign). 1902. Tons.		Exports (Foreign). 1903. Tons.		Exports (Foreign). 1904. Tons.
Refined	731,587	..	761,840	..	664,255	1,928	..	1,695	..	999
Raw	524,727	..	482,739	..	540,971	3,303	..	2,423	..	4,563
Molasses	49,555	..	57,299	..	66,831	122	..	71	..	92
Total..........	1,305,869	..	1,301,878	..	1,272,057	5,353	..	4,189	..	5,654

	Home Consumption. 1902. Tons.		Home Consumption. 1903. Tons.		Home Consumption. 1904. Tons.
Refined..	728,692	..	707,812	..	675,444
Refined (in Bond) in the United Kingdom	—	..	*296	..	392,206
Raw	493,786	..	395,050	.	98,698
Molasses	46,713	..	51,015	..	58,202
Molasses, manufactured (in Bond) in U.K.	—	..	*178	..	44,362
Total..................................	1,269,191	..	1,154,351	..	1,268,912
Less Exports of British Refined.....................	26,546	..	34,711	..	22,251
Total Home Consumption of Sugar	1,242,645	..	1,119,640	..	1,246,661

Stocks of Sugar in Europe at uneven dates, Oct. 1st to 26th, compared with previous Years.

In thousands of tons, to the nearest thousand.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	Total 1904.
95	122	340	82	55	694

	1903.	1902.	1901.	1900.
Totals	1103 ..	1083 ..	484 ..	276

Twelve Months' Consumption of Sugar in Europe for Three Years, ending September 30th, in thousands of tons.

(Licht's Circular.)

Great Britain.	Germany	France.	Austria.	Holland, Belgium, &c.	Total 1903-4.	Total 1902-3.	Total. 1901-2.
1599	1114	720	503	193	4129	3599	3713

Estimated Crop of Beetroot Sugar on the Continent of Europe for the current Campaign, compared with the actual crop of the three previous Campaigns.

(From Licht's Monthly Circular.)

	1904-1905. Tons.	1903-1904. Tons.	1902-1903. Tons.	1901-1902. Tons.
Germany	1,770,000 ..	1,933,435 ..	1,762,461 ..	2,304,923
Austria	1,010,000 ..	1,177,210 ..	1,057,692 ..	1,301,549
France	685,000 ..	804,401 ..	833,210 ..	1,123,533
Russia	1,000,000 ..	1,200,000 ..	1,256,311 ..	1,098,983
Belgium	190,000 ..	203,446 ..	224,090 ..	334,960
Holland	125,000 ..	123,551 ..	102,411 ..	203,172
Other Countries.	340,000 ..	410,000 ..	325,082 ..	393,236
	5,120,000	5,852,043	5,561,257	6,760,356

THE

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☞ The Editor is not responsible for statements or opinions conained in articles which are signed, or the source of which is named.

NOTES AND COMMENTS.

We have to congratulate Mr. Francis Watts, of Antigua, on the Honour accorded him in the King's Birthday List, he having been gazetted a C.M.G. As one of Sir Daniel Morris' staff, he has done yeoman service in the cause of agriculture, especially within the last few years in the Leeward Islands, and we are glad he has met with due official recognition.

The French System of not Refining in Bond.

The *Journal des Fabricants de Sucre* gives us the following interesting intelligence:—

"According to the *Deutsche Zuckerindustrie* of Berlin, the German Government is about to determine whether, and in what measure, the French legislation, and especially the method of taxing the refineries, gives rise to bounties. The French Government, at the instance of French interested circles, also proposes to revise once more its sugar legislation. It is, therefore, not impossible that the French Government may itself modify the provisions which have been subject to criticism, and may do this without the Permanent Commission having to renew its deliberations on this point."

So far as this indicates a disposition on the part of the other parties to the Convention to re-open a discussion which was prematurely closed by the sudden defeat of the British proposals, it is good news. But there are dangers to be guarded against. The French Government will be sure to try to revise their legislation so as to retain the

system of temporary admission, with drawbacks on exportation. That must be avoided.

The German Government may confine their objections to the abuse of the certificates of exportation in the case of the *détaxe de distance*. This would leave the main vice of the French system untouched.

There is no remedy for the present failure of the French Government to adhere strictly to the terms of the Convention except a radical change in the system. France must do as all the other countries have done, refine sugar in bond, pay duty on what goes into consumption, and export sugar which has paid no duty, and therefore receives no drawback. We hope our Government will be firm, and insist on France conforming with the practice of the other countries.

The Rise in the Price of Sugar.

There is no doubt that the price of sugar has risen within the last few months to a considerably higher figure than was generally anticipated at the beginning of the year. It has not only risen from the low artificial prices of two years ago but has even passed the price of "natural production" which is approximately 10s. per ton. But when we seek for an explanation of this unfortunate fact we find that nine papers out of ten, which devote any space to discussing the matter, unanimously condemn the wicked Brussels Convention as the *fons et origo mali*. If, however, we examine the politics of these nine papers we find they are invariably Liberal or Radical organs. It is therefore clear that they are not so much actuated by a sense of the injustice of the Sugar Convention as they are determined to make political capital out of the situation at the expense of the existing Government.

While their real object is thus patent, it would be dangerous to ignore their attacks; since, if they once succeed in persuading the country to agree with their fallacious deductions, no end of trouble may arise in the near future. It is, therefore, a matter for regret that more is not done to controvert them in the columns of the press.* No greater mistake can by made than to suppose that nothing need be done on our part till the time for the renewing of the Convention arrives, in 1908. If we show so laggard a spirit, we may find when that time approaches all our points of vantage occupied by our opponents, much to our detriment. If a Liberal Government is in power in 1908, it may be taken for granted that unless there is a sufficient majority of the country in favour of the juster equity which the Brussels Convention guarantees, a general retreat will be sounded

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*It is only fair to add that within the last week or two the cudgels have been taken up on behalf of the Sugar Convention, especially in the columns of the *Daily Mail*. That widely-read paper had an admirable leader on the subject, reference to which is made on another page.

and the labour of years be brought to nought. It therefore behoves us to be up and doing.

In this connection we are glad to see in the West India Committee's Circular a clear and accurate explanation of the real cause of this abnormal rise in prices. We are yet under the influence of the bounty régime inasmuch as we still get two-thirds of our sugar from the Continent. Consequently when there is a shortage of supplies owing to a partial failure of the beet crop, we cannot expect to escape the consequences. We are paying the penalty, not of joining in the Brussels Convention, but of delaying so long in doing so. We have allowed two or three Continental sugar-producing countries to get such a hold on our market that any fluctuation in their out-put has a corresponding effect on our supplies. The contention advanced, that but for the Convention Russian and Argentine sugars would be available, does not really count for much. These two countries never have sent us such quantities of sugar as would influence the market to any material extent; and against the loss of Argentine sugar we can point to a very large increase in the amount of sugar coming from Java. There has also of late been a slight increase in West Indian supplies. It is clear, therefore, that had there been no Convention, the present situation would have been no better; and it might have been far worse.

But the most telling point in the leading article of the West India Committee's Circular is a very pertinent reminder to the opposition that were it not for the Brussels Convention the home sugar trade might speedily go through a similar crisis to that which the cotton trade has been experiencing the last 18 months. We cannot do better here than quote our contemporary. It concludes: "If bounties had "been allowed to continue unchecked, the sugar industry of our "Colonies, and also that of Java and Brazil, would have been wiped "out, and just as Lancashire is dependent on one foreign country for "her cotton (and her experiences of last year will not easily be "forgotten), so would our consumers have been solely dependent "upon France, Germany and Austria, for their sugar. What would "have been the result? It is obvious that these three countries "would have been quite incapable in the present circumstances of "supplying the wants of Europe, including the United Kingdom, "and but for the Convention having been the means of saving the "cane sugar industry, it is hardly open to doubt but that prices would "have been at a fabulous level and then, perhaps, the Opposition "might have realised the consequence of their folly and started a "Chartered Company for the production of sugar in British "Possessions, as is now being done in the case of cotton." This is very well put and we only hope it will not escape the attention of those who are doing their best by hook or by crook to bring about this crisis.

Nine-roller Mills.

There are two types of nine-roller mill in use at the present day. One type is a compact mill geared to one engine, the other consists of three three-roll mills set tandem, each having its own engine. Hitherto the first-named variety has claimed to be the only genuine one as regards work, economy and results, but the latest reports do not suggest that it is altogether having its own way. A great deal was made of the importation of a nine-roller mill by American makers into Demerara some while ago, and it was supposed that no British mills of the same description were forthcoming, though mills of the three-3-roll-mills-in-tandem type were offered. Whether this was so or not, it is not our present purpose to enquire, but there is a sequel that ought to be mentioned. The owners of the nine-roller mill recently bought three properties on the other side of their local river, and combined three old mills of British origin—mills 20 to 30 years of age—and with this patched up arrangement they are said to be obtaining within 0·5% of the extraction obtained from the brand new American nine-roller mill on the other side of the river. As this combination was made after the American mill had been erected, the results obtained from the latter were apparently not considered good enough to warrant them in ordering a similar mill for their new property. The moral of this seems to be that the craze for multiplication of mills and rollers can be overdone, and we do not think there will be much demand for the latest fancy—a twelve-roller mill. At all events it will have to establish its superiority pretty conclusively before manufacturers go to the very considerable expense of getting one.

Basket Sugar.

In this number will be found a detailed description of a simple method of making "basket sugar" such as should appeal to our West Indian and South American readers. It has been put to a thorough trial during a period of several years in the Straits Settlements, and has proved very successful. We understand that Messrs. McOnie, Harvey & Co., of Glasgow, are interesting themselves in this process, and are prepared to supply the necessary plant for its adoption. They evidently consider there are many plantations where its introduction would prove profitable. By the way, this firm have recently altered their name to "Harvey Engineering Co., Ltd." As Sir William McOnie who died in 1894 was the last of that name to be interested in the firm, the present directors have evidently thought it advisable to drop the "McOnie." We have no doubt they will ere long be even better known and respected under their new title.

THE PRICE OF SUGAR.

Within the last ten days or so the columns of the English press have been opened to a multitude of letters, mainly issuing from manufacturing confectioners and their supporters; the one theme has been the considerable rise in the price of sugar; the one blameworthy feature the Brussels Convention. A good deal of arrant nonsense has been written, especially in the halfpenny morning and evening papers. But even some of the most virulent opponents of Convention are forced to admit that the shortage of the crop on the continent is a factor that has to be taken into account. They however minimise this, the real and direct cause, and seek to prove that had there been no Brussels Convention there would have been no shortage of supply. How would they then explain the large increase in the imports of cane sugar to this country, as shown in following table:—

IMPORTS OF RAW SUGARS FOR NINE MONTHS ENDING

	Sept. 30, 1903. Cwts.	Sept. 30, 1904. Cwts.
Java	318,373	1,431,822
Peru	277,978	839,506
Mauritius	264,040	495,351
B.W. Indies	556,309	824,521
	1,416,700	3,591,200

Here are given the figures of import from four principal cane sugar countries, and the very large increase can only have resulted from the confidence begotten of the Brussels Convention. If these countries can show such a satisfactory improvement in the course of one year, we can rightly claim that the Brussels Convention does tend to increase our sources of supply. The loss of sugar from the Argentine Republic amounts to some 500,000 cwts., but this figure makes little impression on the increase recorded above.

In the *Daily Mail*, at any rate, the Confectioners have not had it all their own way. Mr. George Martineau, C.B., wrote a very spirited letter to that paper, dealing graphically and lucidly with the real causes of the sugar crisis. He entirely confuted the statements made by the Editor of the "Confectioners' Union" in a previous number of the paper, which had given *in extenso* the views and conclusions of the confectionery trade. The *Daily Mail* itself took a very sensible view of the situation, and correctly diagnosed its origin. It tackled the confectioners, and showed them they were abusing the wrong cause.

"While sugar-refining," it said, "was ruined in England by bounty-subsidised sugar, a certain number of manufacturers of confectionery made considerable profits from the fact that they obtained their raw material,

sugar, far below its natural price. We never heard that they shed any tears over the collapse of the sugar-refining businesses which was due to unfair competition, but now that the conditions have been made perfectly fair to all concerned according to free trade principles, they are the first to cry out. They complain that they are subjected to the competition of the Continental manufacturer, who can send his confectionery into this country without paying any special duty. But that is the position of every manufacturer of every sort of goods under free trade, and the remedy for it seems to us to be the taxation of foreign confectionery. They have not to face such an unfair and tax-aided attack as the sugar-refiner had to withstand. In process of time the dearness of sugar will pass, as the Colonies and Java increase their production, while it has also to be remembered that in the present year, owing to the abnormally dry summer in Central Europe, there has been a shortage of nearly a million tons. This alone, without any Convention, would account for the rise in the price, but not even the British Government has the power to alter the seasons. It is the weather, and not the Convention, that the confectionery manufacturers should abuse."

STOCKS OF SUGAR ON 1ST SEPTEMBER, 1904.

According to Licht's figures, the stocks of sugar existing on the 1st September last (calculated in tons of raw) were as follows:—

	1904.	1903.
United Kingdom	96,630	139,049
Germany	245,756	320,880
Austria	134,924	74,018
France	500,126	635,322
Belgium	75,942	104,370
Holland	10,048	33,631
Hamburg	50,826	198,885
United States	125,786	234,929
Cuba	42,714	200,214
In Transit	147,640	85,244
	1,430,392	2,026,542

In criticising these figures, Sachs points out that Willett and Gray give the quantity of sugar in transit to America alone as 375,000 tons in 1904 and 200,000 tons in 1903. Czarnikow gives the figures for the sugar in transit on September 1st, 1904, from Java and the Philippines as 147,640 tons. Licht has therefore evidently taken Czarnikow's Java and Philippine figures for his calculation of total stocks; which all goes to show the uncertainty of these calculations.

SCIENCE IN SUGAR PRODUCTION.

By T. H. P. Heriot, F.C.S.

(Continued from page 532.)

6. The Control.

The foregoing review would be very incomplete were we to ignore the forces which control the operations and machinery we have attempted to describe. Of these operations, some appeal to the special knowledge of the agriculturist, others to that of the botanist, the engineer, or the chemist. Progress in sugar production has therefore necessitated that division of labour which forms so striking a feature of modern industrial enterprise.

Inasmuch as no industry can be progressive which relies upon gratuitous assistance or advice, our final enquiry will be to ascertain whether the sugar producer and his staff combine the requisite technical knowledge and ability to control the operations we have reviewed, and to benefit the industries in which they are engaged, by successfully attacking the problems which lie before them.

The Beet.

In the production of sugar from the beet, the agricultural and manufacturing operations may be almost regarded as distinct, but mutually dependent, industries. The sugar fabricant, however, requires the agriculturist to sign a contract in which the price of the roots is fixed according to their saccharine richness, also the date of delivery and other conditions fully specified; and, consequently, the sucrerie is the active centre upon which the entire industry hinges, and from which all its ramifications are directly or indirectly controlled.

Behind the machinery we find a resident engineer and his staff of mechanics labouring to utilise every shovelful of coal entering the furnaces with the maximum efficiency. Adjoining the factory is a workshop equipped with modern tools and offering every facility for repairing machinery in case of accidents.

The services of an advising engineer are also available when matters of special importance require an expert's opinion; for example, the introduction of new plant, or the modification of existing machinery. The advising engineer having generally several usines under his charge, has exceptional opportunities for studying different working conditions, and the mechanical efficiency of various types of machines, and is, therefore, in a position to afford valuable assistance to the designers of sugar machinery by studying the performance of their machines under actual working conditions.

Formerly, the profits of the sucrerie were considerable, high market prices more than compensating for the costly and imperfect methods of manufacture then in vogue. But, to-day, the fabricant must exercise the strictest economy if his produce is to yield him a satisfactory balance after paying for his raw material and working expenses. No longer able to pay a fair price for roots of indifferent quality, or inferior saccharine richness, he requires to know how much sugar enters his factory in the raw material; how much he recovers in a marketable form; what percentage he fails to extract from his molasses, and other by-products; and what manufacturing losses remain to be accounted for, and if possible, to be reduced. Such valuable information being only available by the skilful use of the balance, the measure flask, and the polariscope, the chemical laboratory has become the "intelligence department" of the sucrerie, or, in Horsin-Deon's words: "The usine without a laboratory is a body without a soul."

In addition to possessing administrative and commercial ability, the modern *fabricant* must be familiar with the special problems of the cultivator, engineer, and chemist, with whom he is in daily consultation; the leaders of the industry being experts in these technical matters, and also frequently the authors of new methods and improved machinery.

Subordinate to the *chef de fabrication*, the various operations in the sucrerie are under the supervision of several chemists, the speed and accuracy of their chemical control being greatly facilitated by automatic methods of sampling the various materials worked up in the factory.

The fabricant no longer pay for his beets by weight, but by their saccharine richness, as determined by the chemists in charge of this department; and the composition of the raw material thus forms the basis of the chemical control, which has a twofold object—first, to account for the sugar entering the factory in the form of raw material, and, secondly, to detect any abnormal variations in the composition of the factory products, which may arise from faulty work and hence require immediate attention.

The supply and density of the juice, and the efficiency of the extraction, being alike dependent on the proper working of the diffusion battery, the latter may be regarded as the mainspring which sets the entire sucrerie in motion. The battery itself is in no sense an automatic machine requiring to be merely fed with beet-slices; on the contrary its operations and efficiency require a constant and intelligent manipulation of the valves, which can only be acquired by long practice. Hence, in addition to the purely chemical control, which records the loss of sugar in the exhausted slices, the movements of the juice through the battery are simultaneously recorded by automatic appliances, of which Horsin-Deon's register

may be taken as an example. This comprises a drum which can be slowly rotated by clock-work, and a lever, carrying a pencil, which is set in motion by a float in the juice measuring-tank. The external surface of the revolving drum being covered with paper, a diagram is thus traced, which records every change of level in the measuring-tank during the spell of 12 hours, the general principle of the apparatus being similar to that of the recording barometer. Each movement of the lever actuates a mechanical counter, which shows at a glance the total number of diffusers worked; and two electric bells give automatic signal to the battery-foreman at the exact moment when the juice-valves should be opened or closed.

This apparatus faithfully records every irregularity in the work, and any accidents or blunders on the part of the battery-men; it is generally placed under lock and key near the battery, or is preferably arranged to operate at a distance so that it may be erected in the laboratory, under the eye of the fabricant or his staff. In the register invented by Laugen, the juice drawn from each diffuser is not only measured, but its density is also automatically determined and recorded.

As such appliances cannot prevent mistakes being made, the fabricant has to rely upon the conscientiousness of his battery-foreman, whose position is one of considerable responsibility. His duties mainly consist in operating the valves which control the motion of the juices in the battery, his subordinate performing the minor duties of charging and discharging the diffusers under his supervision.

In his system of "diffusion by forced circulation" M. Naudet has introduced a mechanical method of controlling the working speed of the battery, so that the fabricant can obtain the desired output of juice per diffuser in a given time. A translation of M. Naudet's description of his process appears on another page of this issue, to which the reader should refer.

Although the chemical control necessarily centres in the laboratory, similar methods are adapted for use in the sucrerie, more especially in that department where the purification of the juice is in progress. The foreman in charge of the carbonatation tanks is furnished with a small laboratory bench, fitted with testing apparatus specially designed for his use, and enabling him to determine, after a few simple manipulations and without calculation, the alkalinity of the juice under treatment, and the precise moment at which the supply of gas should be shut off.

At the close of the campaign, when all is quiet in the sucrerie, the attention of the chemical staff is directed to the analyses of soils and fertilisers, and to the all-important chemical methods of seed selection, which were referred to in a former paper.

We thus note that the various technical aspects of the beet industry are directed by those who are specialists in their several departments, whilst the rank and file of the beet industrials comprises a class of labour which is second to none, and which must be reckoned as a prominent factor in the general progress of the industry.

The Cane.

In the West Indies, we find both agricultural and manufacturing departments of the sugar industry united under the control of the planter, or manager of the estate, whose special qualifications as an agriculturist may serve to distinguish him from his Continental rival, the beet sugar *fabricant*. Starting his career as an overseer, he gains the coveted position of manager by dint of hard work, combined with administrative ability. Practical experience is necessarily the essential qualification, but, as this is rarely backed up by a scientific training, any deviation from customary practices is regarded with suspicion and disfavour.

He is assisted in the general supervision of labour by a numerous staff of overseers, most of whom are engaged in the field, but an experienced "buildings' overseer" is left in charge of the manufacturing operations when the field work demands the manager's personal supervision.

The absentee proprietors are locally represented by attorneys, who control all financial matters connected with their estates, and whose long practical experience as planters entitles them to act as expert advisers to the managers during their periodic visits to the different estates under their control.

The professional engineer is responsible for the proper working of the machinery, and advises the manager or the attorney regarding any alterations or additions he may think desirable. He seldom resides on the estate, but is generally in charge of several factories, which he frequently visits. On each estate, he can generally find a trusty negro mechanic capable of supervising the handling of the machinery, and of carrying out minor alterations or repairs during his absence.

Several proprietors of West Indian estates conjointly retain the services of a consulting engineer in London, who is consulted on all matters of importance, and who attends to the machinery orders received from the estates' engineers.

No serious attempt has yet been made to submit the manufacturing operations to chemical control on the lines adopted in the rival industry; for, whereas the large majority of factories dispense entirely with the chemist's services, the most up-to-date factories have always limited their chemical staff to one resident. Estimating the number of chemists directly engaged in sugar factories as at the most a dozen, these are distributed between con-

siderably over one thousand West Indian factories, of which only about 140 are equipped with modern machinery. We thus find one chemist to every 90 factories now in operation, or one to every twelve of the more modern factories. Being, therefore, the rare exception rather than the rule, the chemist has to work single-handed with such assistance as he can look for after training others to execute the simpler tests; a practice which, although rendered necessary by circumstances, is far from satisfactory as introducing uncertainty where accuracy and certainty are aimed at. To be of any practical value, the chemical control of a sugar factory would involve an amount of laboratory work and supervision in the factory which would fully occupy two or even three chemists on each working spell. Accurate analyses of isolated samples cannot represent the mean composition of the materials treated in the factory; and, even when the system of sampling is all that can be desired, the analytical work is frequently rendered futile by errors in weights of canes or measurements of juice, which are beyond the control of one chemist, although forming the basis of all his calculations. Thus handicapped he must be content with a partial control based on the saccharine richness of the expressed juice instead of on the actual percentage of sugar in the canes ground; approximations based on mathematical formulæ being generally unreliable as compared with direct analytical data.

Similarly, if he desires to carry out experiments in connection with the cultivation, the only assistants at his disposal are such as cannot appreciate the many precautions required to arrive at reliable information, and, although he may give detailed instructions as to how the experiments are to be carried on in his absence, the results will generally be doubtful, if not absolutely contradictory.

Finally, we may note that West Indian labour compares most unfavourably with that on the Continent as regards intelligence and reliability. The negro agriculturist of the old type is now rarely found outside Barbados. Where he comes into contact with indentured coolie labour, he has come to regard continuous employment as only one step removed from slavery, and therefore beneath the dignity of a free British subject. His services cannot, therefore, be relied upon by the estates when labour is most needed, although he is ready enough to cultivate his own land, and within recent years, has become a successful cane farmer. As he can put his hand to various crafts, a steady worker has no difficulty in finding employment in the sugar factory, and makes a good workman so long as no great demand is made upon his reasoning powers. He is to be found in charge of the vacuum pan in every factory, and frequently earns high wages by his proficiency in the art of sugar boiling. The indentured coolie forms a striking contrast to the native, excelling him in intelligence, but lacking his muscular strength. The higher

caste coolie has considerable control over his less fortunate countrymen, and is therefore of great service as a driver in charge of the gangs working in the field. Although hailing from a somewhat different climate, the coolie can bear exposures to sun and rain which do not agree with the deteriorated constitution of the native, so that coolie labour is mainly restricted to the cultivation, whilst the negro is available in the factory.

(*To be concluded.*)

RAW SUGAR WORKS OR REFINERIES.

BY SIGMUND STEIN.

(Sugar Expert, Liverpool.)

Very many people will ask themselves if there is any difference between raw sugar works and refineries, and if so where it lies; and if not, why make this distinction? For my own part I consider a distinction between them as out of place. The raw sugar works or raw sugar factory is a place where sugar is extracted from the plants and boiled and refined into sugar. This boiling and refining of the raw juice can be carried out to a certain degree and to a certain extent: if it is not complete, the place where it is generally carried out is called a raw sugar works; if, however, the process is carried further the name of sugar refinery is applied.

The question now-a-days arises whether it would not be advisable for manufacturers of raw sugar to carry their process a little further and place on the market an article ready for consumption, as in that case they would combine both the qualities of a raw sugar works and a sugar refinery. Now-a-days where the processes of refining have fallen into so many different channels, where it is proved that charcoal is not any more a necessity, and where it is shown by the highest experts that a first class sugar can be made without the aid of animal charcoal, it is a matter for wonder that many raw sugar manufacturers do not turn out sugar for consumption direct. This applies to our colonies in the West Indies and elsewhere, also to all other cane-growing countries. Very often raw sugar does not find a suitable market, whereas sugar for consumption would find a very ready market, and would demand a very high price. There is not always a very large demand for raw sugar for the manufacturer, but if he could produce a finished article—that is, sugar ready for consumption—he would increase his profit greatly. Again, he could cater not only for the refineries, but deal direct with the consumer. There is no question of cost. A very small works could instal at a trifling expense a plant by which they could make sugar ready for consumption in any form whatever required. They could turn out

crystals, cubes, fine powdered sugar, fine yellow sugar, and golden syrup, all without any extravagant installations, without unnecessary expense, and without increasing unnecessarily their plant.

I have described repeatedly in the columns of this journal several suggestions and processes of mine by which sugar for consumption could be made by simple means and by simple appliances. I have received already numerous communications from all parts of the world on this subject. I have described often enough how easy it would be for a small plantation to have this small additional "refinery" for the case of emergency, and so make a sugar which would compare very favourably with the sugar turned out in the sugar refineries with the aid of animal charcoal.

If these estates would follow my advice and try the experiment they would find that the experiment would be worth the slight trouble and the trifling outlay of capital, for they would be establishing a new trade, they would be laying the foundation for a large and increasing prosperous export trade with sugar direct for consumption. They could, for instance, find a ready market in England, where the large jam and confectionery industry would gladly take their sugar. They could also easily find a good outlet in the Colonies themselves. In this process, the molasses which result could easily be brought into a very fine state and made into golden syrup, for which a market already exists all over the world.

These are only suggestions of mine, which I lay before the planting communities for their consideration and discussion. I should be very glad if the few hints I have given should lead to a new branch of work, and I should be happy if I should be the means of introducing to them a new and profitable business.

It is intended to lower the Belgian Consumption Tax on sugar from 51·75fr. to 20fr., and a Bill has been submitted to the Chambers to give effect to it.

In Fiji, the C. S. Refining Co., of Sydney, have started a new mill at Lautoka, in consequence of which the output of sugar in these islands will shortly show a considerable increase

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The *Official Journal*, Paris, publishes a decree fixing the following countervailing duties on sugars: on refined sugar from Canada, 3fr. 63c. per 100 kilos.; on raw sugar from the South African Customs Union, 2fr. 65c., and on refined sugar, 3fr. 89c.; on raw sugar from the Australian Commonwealth, 94c., and on refined sugar, 5fr. 62c.

HAWAIIAN ISLANDS.

THE SUGAR CAMPAIGN OF 1903-04.

The sugar production in the Hawaiian Isles for the year 1903-04 falls slightly behind that of its predecessor. It has not responded this time to the hopes which were justified by the results obtained in 1902-03. The following figures, culled from the statistics published in the local press, give an exact idea of the progressive movement which has followed the development of this industry since 1897, and this year reveals a check in the increased production:—

	Tons.		Tons.
1897-98	229,414	1901-02	365,611
1898-99	282,807	1902-03	437,991
1899-1900	289,544	1903-04	380,000
1900-01	360,038		

During the seven campaigns mentioned in the above table, the development of the industry, which is the mainstay of the islands, has continued and progressed from year to year. During some years, thanks to the perfection of field work, and the creation of an agricultural experiment station and experimental laboratory, the culture of the sugar cane in Hawaii has almost doubled in production and the cultivated area increased by several thousands of acres. If the last crop has not attained to the figures of the preceding one—having fallen short by 57,000 tons—one has to take into consideration the presence of an insect which has made its appearance in certain plantations, and which threatens at present to spread over the whole territory. This insect, known as the "Leaf Hopper" (*Perkinsialla Saccharicida*) was introduced into those islands three years ago with some canes imported from Queensland. Like all insects of this class, the Leaf Hopper secretes large quantities of a clear sugary liquid, called "honey dew," which attracts other insect parasites, and thus facilitatates the propagation of the "Rind Disease," and of "Cane Spume," two kinds of cryptogams which tend to fix themselves in the stem of the cane and cause its eventual destruction.

Under these circumstances, giving rise as they do to serious apprehension amongst the Hawaiian planters, it is easy to see that if the experts called in by the agricultural bureau do not promptly evolve some remedy capable of putting an end to the ravages of this pest, the Hawaiian sugar industry will soon suffer serious damage in its production.

The mean prices for raw sugar have been as follows:—November, $3\frac{1}{4}$ cents per lb.; December, $3\frac{1}{4}$ cents; January, $3\frac{1}{2}$ cents; February, $3\frac{1}{4}$ cents; March, $3\frac{1}{4}$ cents; April, $3\frac{1}{2}$ cents; May, $3\frac{1}{2}$ cents; June and July, $3\frac{3}{4}$ cents; August, $4\frac{1}{4}$ cents.—(*French Consular Report.*)

NOTES IN CONNECTION WITH THE MILLER PROCESS FOR MAKING BASKET SUGAR.

This process has already been shortly referred to in the *International Sugar Journal*, 1901, page 469, but the following details will be necessary in order to clearly describe it:—

The process, up to the evaporation in the triple effet, is the same as that usually carried on for the manufacture of non-chemical sugar. After leaving the triple effet the liquor then enters the finishing battery. The boiling in the finishing battery is carried much further than when making muscovado sugar. The point of completion is found by taking up a portion of the boiling sugar from the pan with the finger, which has been previously wet, and cooling it by blowing on it. If the sugar is properly cooked, the portion of sugar on the finger will harden and get brittle. Of course a piece of wood can be used instead of the finger for the same purpose.

The point of striking is important, as, if the sugar is under-cooked, it may not dry properly in the trays; and if overdone it is of fine grain, and does not break up so easily.

The time of boiling also has to be varied according to the purity of the juice; a good juice usually takes less time to boil up than one containing considerable impurities.

The pan is fitted with a valve door, so that the charge is run quickly out and is lead directly into a drying tray by a gutter. The success of the process depends greatly on using small charges at a time. The usual amount of sugar made in one charge is about 200 lbs., and the time to boil this up should not exceed 30 minutes at the most.

During the clarification and cleaning of the juice excess of lime is quite unnecessary and wasteful; neutral working gives the best results.

The boiling sugar from the pan is then run through a gutter into a drying tray. In a large works, making 20 tons in the 12 hours, it is run into a small truck on the railway and delivered into one of the drying trays. A drying tray consists of a wooden box, 12 ft. long × 6 ft. wide, and about 6 in. deep. They are smooth on the bottom, and the seams are grooved and tongued, and the boards are screwed down on to 2-3 in. scantlings underneath, the heads of the nails being countersunk in the inside.

The charge, after cleaning down the gutter with the spade, is spread out evenly over the surface of the box. This spade consists simply of a $\frac{3}{16}$ in. steel plate, the top four inches of which is bent round to form a scoop, leaving about eight square inches of shovel below; the bottom edge is bevelled off in order to give it a face. The charge in

the box is now pushed evenly backward and forward over the box till it thickens. This will happen—if good juice and properly cooked—in about three minutes. It is then levelled off evenly over the whole surface of the box. The charge will then be about 1½ in. deep. It is then left 10 to 15 minutes at rest till the sugar has formed and the molasses has been absorbed. The proper time will be noticed when using the spade to turn it over. The latter, after levelling off in the first process, should be scraped clean. When used for the second stage the sugar will not adhere to it if the interval of time for drying has been properly judged. The second turning resembles ploughing, the bottom layers being brought to the surface as much as possible. This is done with the spade, walking up the length of the box and taking the three feet of sugar farthest from you.

The sugar should now be loose, with large, soft lumps, and the second turning over with the spade should be done to hasten the cooling. When this is accomplished the lumps are broken up by being pressed by a round piece of wood on which the foot is placed, while a twisting motion is given by the handle. For a high quality of sugar the breaking may have to be done twice over, raking in between.

The sugar, when cool, is ready for packing, and it should be rammed tightly into the package. It is quite dry and pulverant, and sandy to the touch. The small lumps are unavoidable, but do not detract from the value, as they have the same sugar content as the powder. The package should be practically water-tight.

When no triple effet is used for the evaporation, the pans should be placed on the copper wall in the same position as the striking *teache*. But by open evaporation the same quality of sugar will not be obtained as with evaporation in vacuo—that is, the sugar will not polarise so high. With juice of a purity of 90°, and using a triple effet for 80° of the evaporation, the whole of the solids in the juice can be turned into sugar of 85° polarisation.

RECOVERY.—By this process the recovery is the highest possible, having a triple effet or other evaporator for the bulk of the evaporation. The fall in purity from the juice to the finished sugar is not more than 1½° to 2°—that is, supposing the purity of the juice was 83°, the purity of the solids in the commercial sugar would be 81° to 81½°. The only loss that occurs is in the filter press cake, but as the sugar used contains about 3% to 4% of water, this loss is more than made good. A recovery of 100% of the total solids in the juice has been effected over a considerable period in actual working, where careful tests have been made, and even 101·5% has been obtained with low quality juices. Continuous analyses have been obtained over a period of now five years, and the above figures can be guaranteed.

As regards recovery from the sucrose in the juice, this depends greatly on the purity of the juice, and, strange to say, the lower the purity of the juice, the higher the recovery effected: thus, if the juice has a purity of 90°, 111·11 % of commercial sugar will be obtained from the 100 parts sucrose in the juice, while if the purity is 80°, 125 % will be obtained. Of course the sugar in the one case will polarise higher than in the other.

One workman is sufficient to attend to the boiling of six pans set in one battery—that is, two lots of three each. The working up of the sugar from that battery can be done by four men; besides these, there is, of course, the fireman for attending to the furnace. Each pan strikes 200 lbs. in 30 minutes; therefore six pans yields per hour 2,400 lbs. dry sugar.

Some Advantages from the Use of this Process.—One of the chief advantages of the process is the rapidity with which the sugar can be obtained in a dry condition. This, in ordinary working, should not exceed two hours after the juice has been obtained from the cane, every day's work being finished off a few hours after the mill has stopped.

The recovery obtained is the highest possible, and the quality of the sugar is the highest that can be obtained without eliminating the molasses. In practice it has been found that the megass saved from the boiler furnaces has been sufficient to effect the final evaporation. The loss from evaporation of the oil is practically nil, and the continual heating of it does not destroy the oil, the same oil being used over and over again.

NOTES FROM MAURITIUS.

The annual report for 1903 of the *Station Agronomique* contains some notes on the utilisation of cane molasses as fodder, and, as the preparation employed is identical with that adopted by Mr. George Hughes in his patented "Molascuit," the following abstracts should be of special interest to the cane planter:—

In the preceding bulletin we endeavoured to show the numerous advantages of utilising part of the molasses produced in the usines as food for stock, and which has since been practised on a more or less extensive scale.

It is very difficult to determine exactly to what extent the usual fodder can be replaced by saccharine matter such as molasses, although information on this point is most desirable. Theoretical considerations, based on the chemical composition of the food, being somewhat unreliable, it is necessary to resort to actual observation and the best means of ascertaining the general condition of an animal

is to determine its weight from time to time. For this purpose it is quite unnecessary to weigh all the animals under experiment, but if two or three are selected as representing the average and weighed on the estate's scale every Monday morning, for example, no considerable amount of work need be demanded, and may even be largely compensated for by an intelligent interest in the matter on the part of those in charge of the stables. Assuming the work of the animals to be fairly regular, a constant weight proves that the ration is suitable, whereas a diminution in weight proves that the animal is insufficiently nourished and that the food requires modification; this being the most certain method of controlling the gradual substitution of saccharine food for that generally employed.

We have recommended the mixing of the molasses with fine megass, the latter being an excellent absorbent and easily procurable during the crop season, but we hope that when its advantages are appreciated the planter will not hesitate to procure suitable machinery for reducing the ordinary megass and other fibrous plants to the required degree of fineness.

There is only a trifling difference in composition between the ordinary and the finer particles of megass, the fibre of the latter is, perhaps, a little more digestible, but the difference is not sufficient to to be taken into consideration. In the following analyses, the fine megass contains no sugar owing to the rapid fermentation of the contained juice before the material was collected from the factory yard; the whole megass, taken from the usine, was immediately dried and therefore still contains sugar, but if left lying in the yard the sugar similarly disappears, and the two portions of megass become equal.

	Dry Megass.		Wet Megass.	
	Ordinary.	Fine.	Ordinary.	Fine.
Water	—	—	12·00	12·00
Ash	1·14	3·39	1·00	2·99
Cellulose (insoluble)	43·48	41·00	38·24	36·08
,, (soluble)	41·17	49·40	36·23	43·47
Sugar	11·00	0·00	9·68	0·00
Nitrogenous matters	1·73	2·06	1·52	1·81
Other substances	1·48	4·15	1·33	3·65
	100·00	100·00	100·00	100·00

In the majority of cases a large part of the customary fodder can be suppressed with advantage and replaced by saccharine matter, but it goes without saying that a complete substitution cannot be made; both kinds of food are indispensable, but a too abundant use of grain supplies an excess of nitrogenous matter which is imperfectly utilized, and the reduction of which can be economically affected by the addition of sugar.

The more moderate ration suitable for maintaining animals in proper condition when at rest, should be supplemented by one rich in

hydrocarbons when they are put to work, and the addition of molasses to the usual fodder is then of great service.

The stock of animals on the sugar estates having been much reduced, all the molasses produced in the usines cannot be utilised in this manner, although a considerable proportion can be given without inconvenience, since, in the Fiji islands, as much as 15 lbs. has been regularly given per animal weighing from 1200 to 1300 lbs., which sufficiently demonstrates that the usual quantity of grain can be very largely reduced.

As the selling price of molasses has been exceptionally low of late years, their utilisation in this direction is the most rational, care being taken to employ fresh molasses or such as have been carefully stored, whilst the remainder may be utilised as fuel or as a fertiliser.

As an example of the results obtained by feeding with molasses we may cite those of the usine "La Laura," where, during the crop, a mixture was prepared containing 80% of molasses and 20% of fine megass, and which served as a supplementary food for the horses on the estate. Those which were working regularly received daily 17 lbs. of a mixture of hay, oats and bran. In February one pound of this mixture was replaced by a pound of molasses-megass mixture, this substitution being gradually increased until at the beginning of April they received 13 lbs. of grain and 5 lbs. of molasses-megass, which was continued until the end of April, when the proportion of grain was accidentally raised to 15 instead of 13 lbs.; there was therefore only a reduction of 2 lbs. of grain per day, when probably a reduction of 4 or 5 lbs. might easily have been made. Two horses were weighed every week, with the following results:—

		No. 1. Kilos.	No. 2. Kilos.
April	17	420	376
,,	24	421	380
May	1	418	377
,,	8	420	380
,,	15	417	380
,,	23	425	378

The weights being constant, the ration was therefore amply sufficient, and we believe that the same results would have been obtained had the proportion of grain remained at 13 lbs. The general opinion, and particularly that of the man who had charge of the stables, was that the horses showed more vigour and energy than before the experiment with molasses was commenced, and that this method of feeding was entirely satisfactory. As one is generally inclined to criticise any modification of every day practices, especially when these complicate rather than simplify the work, the above observations were not devoid of value.

Maize is not employed as frequently as it might be for feeding stock, especially when a good price can be obtained at the harvesting

season. As it deteriorates when stored, it is of interest to ascertain whether it is of equal nutritive value after storage as the same weight of fresh maize. Analyses were made to determine this point, but do not show any striking differences, the sum of the nutritive elements being represented by 115·6 and 117·9 units in the fresh and deteriorated maize respectively. It is, however, necessary to take into consideration that deteriorated maize is more or less mouldy, and contains innumerable bacteria, which might have an injurious effect on animals from an hygienic point of view. The maize should be carefully stored in closed receptacles, and all insect or bacterial life destroyed by thorough drying, or by exposure to the vapour of carbon bi-sulphide; the additional cost of such treatment being more than covered by the greater value of the maize so preserved.

The 1903 campaign has been exceptional from an agricultural point of view, and had the selling price been normal, the financial result would have been most favourable. This considerable increase in production was due neither to an increase in the cultivated area nor to more perfect and intensive cultivation, but simply to exceptional meteorological conditions, namely, the favourable distribution of the rainfall, and the absence of cyclones and violent winds, which loosen the cane-stools and destroy the foliage. If, during the drier seasons, an insufficient rainfall could be supplemented by a moderate irrigation, the yield per acre would be more regular, and except under most unfavourable circumstances, would be generally higher than those actually obtained. When we consider the rapid increase in in production mainly due to irrigation in Hawaii, it is evident that the available water is not properly utilised in Mauritius, the larger part of the surface water being entirely lost. By adopting the methods employed in Hawaii, a very large area might be effectively irrigated with the supply of water now available. This has already been tried in Mauritius by M. G. Aubin on the lands of "Chebel," and the advantages are so evident that the system has been promptly adopted by the owners of "Beau Plan."

The manufacture of sugar tends to become centralised more and more, and, during recent years, several usines have been closed, and their canes worked up in neighbouring factories. The purchase of canes is therefore a problem the importance of which increases daily, and it has been often proposed to pay for the canes according to their saccharine richness or, rather, on the density of their juice. This is certainly the best basis of payment, the buyer paying for the amount of sugar he receives. With a uniform price, he has the advantage with rich canes, but runs the risk of a loss when the canes are inferior. But with the great variety of canes cultivated, the density of the juice does not always correspond with their saccharine richness, nevertheless this would always be an advance on the present system in which control is entirely

absent. Analysis alone can furnish a basis of payment according to the real value of the canes, and, although such control would certainly complicate the reception of canes at the usine, it would not be impossible. The main difficulty would lie in obtaining a representative sample, and the most practical method of effecting this would be to analyse the juice expressed by the first mill, thus obtaining a much more reliable result than when operating on a small lot of canes. When canes from the same property arrive simultaneously and are discharged upon the carrier direct from trucks, the taking of the sample would be a simple matter. When carted to the usine, it would be equally necessary that the canes coming from the same property should be unloaded at the same time and fed to the mill without admixture with other canes, or that they should occupy a certain length of the carrier and thus render it possible to collect a sample of their juice from the mill. But when the carts from the same proprietor arrive singly or cannot be brought together at the mill, the difficulty becomes much greater. A dozen canes may then be taken from each cart and placed in a heap marked with the number of the seller, and, at the end of the day, all these samples would be crushed together in order to obtain the juice necessary for the analysis. To avoid delays in the feed to the mill, the samples for analysis might be passed through a small experimental mill of sufficient power and driven by a chain from the factory mill.

The analytical control might be dispensed with in the case of cart-loads arriving singly or in small numbers from the same source by fixing an average price for their reception, unless the small proprietor or farmer agrees to share the expense which such control necessitates.

It would be to the interest of the manufacturer to pay for the more important deliveries on the basis of the sugar he can extract. The simple density would be better than no control whatever, but it fails to indicate the exact value of the juice. Selecting from the laboratory analyses the following examples, we find two juices having a uniform density of 10·3 and two of 11·2 Baumé :—

	Density 10·3.		Density 11·2.	
	No. 1.	No. 2.	No. 1.	No. 2.
Sucrose, per cent. in juice	16·69	14·23	18·91	16·45
Glucose ,, ,,	0·46	2·12	0·17	1·81
Sucrose ,, in canes	13·85	11·95	15·88	13·81
Glucose ,, ,,	0·38	1·78	0·14	1·52
Glucose, co-efficient	2·7	14·8	0·9	11·0
Purity ,,	88·3	76·0	92·8	80·0

The sucrose per cent. canes is calculated from the factor 0·84. Assuming an extraction of 70 kilos of juice per 100 kilos of cane, the sugar entering ths usine is represented in the following table as "Extraction," the manufacturing yield being represented by column A. when calculated on 80% of the sugar entering the factory,

and by column B., when calculated on the purity as is generally done.

	Degrees Baume.	Extraction.	Yield per cent. on Canes. A	B
No. 1	10·3	11·54	9·20	10·17
No. 2	10·3	9·96	7·96	7·59
No. 1	11·2	13·23	10·58	12·27
No. 2	11·2	11·51	9·20	9·30

For juices of the same density, the return of sugar per cent. cane will therefore vary from 7·96 to 9·20, and from 9·20 to 10·58 with an extraction of 80%.

Naturally, with canes yielding juice of different densities, the results will be still more variable. It is for this reason that an erroneous valuation of a given variety of cane frequently arises when the yield of sugar per acre is adopted instead of the weight of cane, the latter being the only figure actually known. The figures obtained by multiplying the weight of cane by the average manufacturing yield obtained in the factory will vary enormously with different varieties of cane, as may be easily proved by working up each plot of canes separately, and will be more or less considerable even with the same variety of cane.

Taking the extreme figures in the preceding examples, namely, 7·86 and 10·58, it is readily calculated that it will require 1272 and 945 kilos of canes respectively to make 100 kilos of sugar, and that a return of 5000 lbs. of sugar per acre would correspond to 31,800 kilos of canes in the former case, and to only 23,620 in the second.

THE SUGAR CANE CROP OF INDIA, 1904-05.

Since the first forecasts were issued in August no further report has been received from Bengal where the crop was then doing well. The prospects throughout Northern India continue favourable and it is expected that the area under the crop in the United Provinces will be well above last year's area. Madras also now reports an extension of the area, which is, however, still considerably below the average, and the crop is in satisfactory condition.

The provincial reports are summarised below:—

In the United Provinces the favourable prospects of the sugar cane crop reported in August continue. The period of incessant rain lasted till the end of that month when fine weather set in. The falls in the second and third weeks of September were sufficient in the greater part of the province except in the Benares and Gorakpur divisions:

in these two divisions the cane crop is at present estimated at 75 to 80 per cent. of the normal. In the rest of the province the crop is reported to be healthy and promising, and a full normal out-turn is anticipated.

In the Punjab the total area is now estimated to be 311,100 acres, as against 312,100 acres in the first forecast and 322,400 acres finally ascertained last year. The crop is in good condition except in Lahore, Gujrat and Sialkot, where it is only fair owing to deficient rainfall.

In the North-West Frontier Province there is no change in the area as compared with the first forecast, namely, 24,600 acres. The prospects of the crop have much improved in Hazara and Peshawar by favourable rains; in Bannu they are average. The out-turn for the province as a whole is expected to be up to the average.

In Madras the total area planted with sugar cane in Raiyatwari villages up to the end of August, 1904, was 42,100 acres, or 7 per cent. more than in the preceding year. It is, however, less than the averages of five and ten years by 9 and 15 per cent. respectively. As compared with 1903 there is an appreciable increase in the South Arcot and Trichinopoly districts. The increase in the former is attributed to the demand for jaggery and in the latter to the early supply of water in the channels. The condition of the crop is reported to be fair to good.

DIFFUSION BY CONTINUOUS AND FORCED CIRCULATION.

(Naudet System.)

By M. L. Naudet.

(Continued from page 548.)

As applied in the Sucrerie.—Fig. 2 represents a battery of twelve diffusers (of 40 hectolitres capacity) furnished with the apparatus previously described. Two regulating valves, V and V^1, are there shown on the pipe-main leading from the re-heaters; the one, V, admits juice to the battery during forced circulation, the other, V^1, admits juice to the measuring tank. The capacity of the circulating pump is always calculated to deliver a larger volume of juice than that which can simultaneously pass by the valves V and V^1.

Suppose, then, that the fabricant wishes to operate one diffuser every five minutes, he must supply during that period 22 hectolitres of juice to the measuring tank through V^1 (namely, the volume

drawn off per diffuser of 40 hectolitres capacity), also 60 hectolitres must pass into the battery through V. This can be arranged for before the campaign commences by adjusting these valves in the following manner:—The pump being started, the valve V^1 is opened, or closed, so as to permit exactly the desired volume of juice to pass to the measuring tank in the required time. Similarly, this valve may be adjusted to allow the given volume of juice to be drawn off in 4, $4\frac{1}{2}$, 5, $5\frac{1}{2}$—up to 10 minutes; the various positions of the valve being recorded on a graduated arc fixed below an index pointer attached to, and moving with, the spindle of the valve. The position of the valve V, which should allow 60 hectolitres of juice to pass to

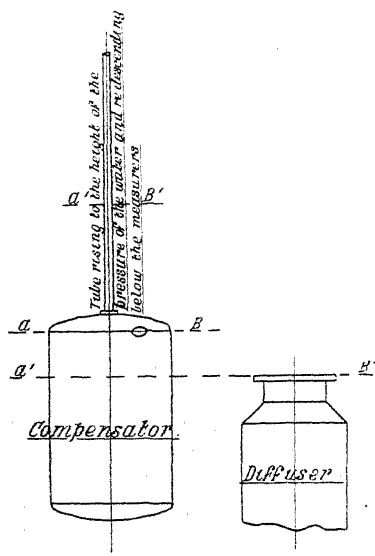

Fig. 1.—The Compensator.

the battery, in the given period, is similarly adjusted by filling a diffuser in $\frac{2}{3}$ of the required time, and repeating this operation for the various periods to which the valve V^1 was adjusted, indicating the positions of this valve as before. Then, in order to operate one diffuser every five minutes, it is only necessary to move these two valves so that the indices move into the pre-determined positions, and, so long as the valves are not interfered with, the time required for these two operations remains unchanged.

Let us suppose that Diffuser No. 4 is empty and ready for charging with fresh slices, also that No. 3 has already been charged and is under circulation, whilst, at the same time, the desired volume of juice is passing into the measuring tank. In order that the operations

of *meichage** and *soutirage** should terminate simultaneously, the former, which should occupy only from 60 to 80 seconds, is not commenced until a certain number of hectolitres have been drawn off. Consequently, the juice-inlet valve on No. 4 is opened after,

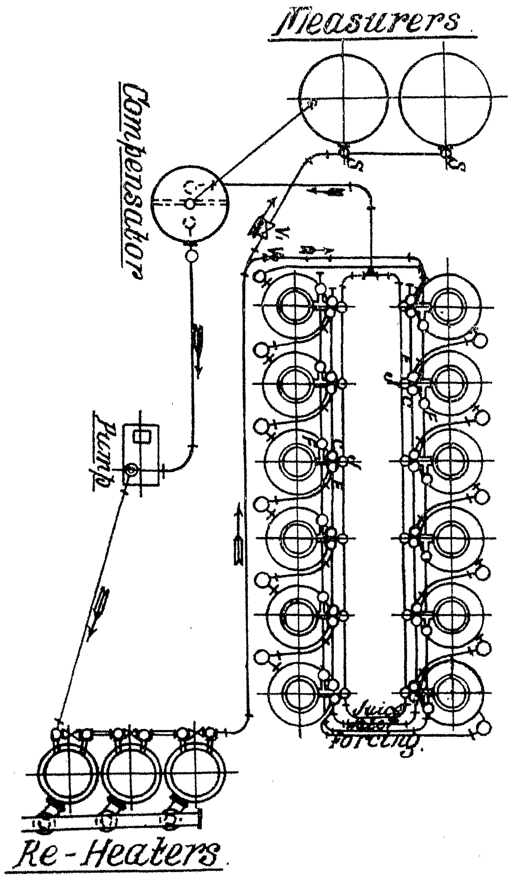

Fig. 2.—The Naudet Battery as adapted to treating Hot Juices in the Sucrerie.

say, 14 hectolitres of juice have been drawn from No. 3. The latter operation, *soutirage*, being completed, the level of the juice in the

* It is convenient to retain these two technical terms for sake of brevity. *Meichage* refers to the entrance of comparatively rich (but impure) diffusion juice to the terminal diffuser (*i.e.*, that diffuser last filled with fresh slices). *Soutirage* refers to the withdrawal of the final diffusion juice (of maximum density and purity) from the battery into the measuring tank.

compensator returns to *a-b* (*Fig. 1*) by the law referring to communicating vessels. During *soutirage*, more juice leaves the battery than is returned to it by the pump, and the level of juice in the compensator rises. The capacity of the latter is so calculated that, when the battery work is most rapid, the compensator is completely filled before the *meichage* is commenced, so that the latter operation is very rapid, juice entering the terminal diffuser from the compensator as well as from the preceding diffuser. Consequently, whenever the battery operations are stopped, there is always a free passage for the juice into the partially filled compensator, and no time is lost in changing the diffuser, the rapidity of the work being thereby greatly facilitated.

Assuming that the battery supplies exactly the required volume of juice for *meichage* and *soutirage* during five minutes, what must the fabricant do when, finding that the battery is working too fast to maintain the proper density of the juice, he wishes to prolong the period of each diffuser to six minutes? Evidently, he has simply to adjust the positions of the valves, V and V^1, to the required conditions without having to give instructions to the men in charge. The compensator being filled with juice before the *meichage* is commenced, the juice rises in the vertical pipe until it automatically exerts a counter-pressure which diminishes the working-speed of the battery. As the juice under circulation meets with this counter-pressure (which is exerted in an upward direction through the bottom perforated plates of the diffuser) the working of the battery is slackened for the time being, but can be greatly increased a few hours later should this be necessary. In fact, we might say that the battery is checked for a certain period in order that the subsequent working may be hastened; and, instead of the difficulty usually experienced in regaining the normal working-speed, my battery remains capable of its maximum output at a moment's notice.

Another case may present itself. The battery is not supplying sufficient juice to the evaporators, so the valves, V and V^1, are adjusted to furnish the required volume of juice in four minutes. During the *soutirage*, which is somewhat more rapid, the compensator will not be completely filled and, during *meichage*, the level of the juice in the compensator descends below *a-b* (Fig. 1), the outlet-valve being partially closed by the motion of the float so that the movements of the juice are impeded. *Soutirage* is also retarded and is only complete when the level of the juice in the compensator again rises to *a-b*, that is to say, after 4 or 4¼ minutes; hence, the float automatically obstructs the free circulation which takes place when the outlet valve is fully opened.

It will therefore be evident that, by this method of working, no attention whatever is demanded from the battery-hands, the responsibility resting solely with the fabricant, who determines at what

speed his battery should be worked in order to adapt the battery to the general requirements of the factory. The diffusion is continuous, yielding a juice of maximum density and spent slices containing a minimum quantity of sugar.

The fabricant need no longer fear that the battery-hands will snatch intervals of rest during the night spell by hurrying the operations in several diffusers, for he is provided with a better means of control than that furnished by the automatic registering apparatus generally adopted.

The *meichage* should be almost instantaneous; the juice, entering the diffuser with a mean temperature of 50°, will scarcely have time to warm the fresh slices before being replaced by hot juice, which immediately has the desired effect. We stated last year that it was preferable to effect the *meichage* gradually and at a moderate temperature in order to avoid decomposition of the sugar, and this plan was adopted during the early part of the campaign. But, we have since proved by analyses that the colder juices, especially when working with frozen or rotten beets, dissolve the saline impurities quite as readily as juices at higher temperatures, and we have therefore decided to conduct the *meichage* as rapidly as possible and thus reduce the period of contact between the slices and the cooled juice—*i.e.*, at temperatures of from 30° to 60° as contrasted with hot juice of 80°. After *meichage* with cooled juices of 80° purity, the juice drawn off did not exceed 77° purity after three minutes' contact (not counting the time occupied by *meichage*). Since increasing the speed of the *meichage*, the analyses indicate that the juice, entering the diffuser at 80°, had almost the same purity as that drawn off by the pump, whilst the purity of the first portion of the circulated juice (which is cooled by contact with the fresh slices) rose to 81, that following to 82, then 83. These comparatively low purities were due to the inferior quality of the roots, the purity of which was from 76 to 79, and even as low as 69.

As applied in the distillery.

The great difficulty experienced in adapting our process to the distillery in 1901 arose from the fact that the juice must be drawn from the battery at a mean temperature of 30°, or a maximum temperature of 35°, whereas our process yields juices at higher temperatures. It was therefore necessary to cool these juices either in a special apparatus or merely by contact with the fresh slices. In attempting to overcome this difficulty by the latter method, certain modifications had to be introduced which greatly reduced the output. The introduction of the compensator has since enabled us to realise our original idea—namely, to retain the method of working adopted in the sucrerie by re-arranging the various pipe mains.

As applied to the sucrerie, the juice leaving the diffuser during the latter part of the circulation had a mean temperature of from 32° to 34° under the following conditions:—

1. The *meichage* was conducted at 80°.
2. The fresh slices had a temperature of 10°.

It is, however, certain that the *meichage* could never have been made at a higher temperature than 65°, and if the slices had a temperature of 10° at the commencement of the campaign, towards

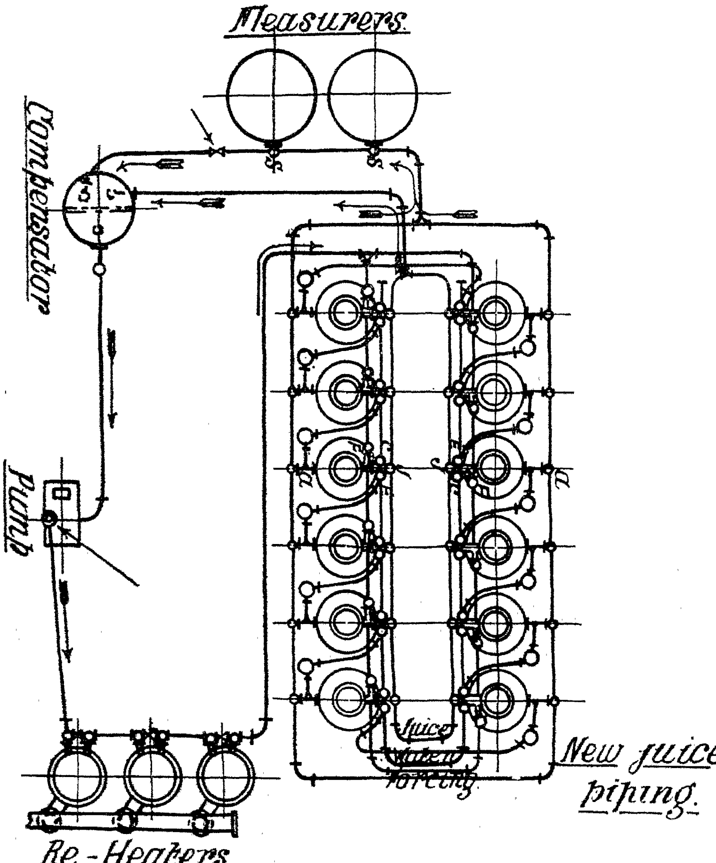

Fig. 3.—THE NAUDET BATTERY AS ADAPTED TO TREATING COOL JUICES IN THE DISTILLERY.

the close of the latter their temperature was much lower and consequently the temperature of the juice drawn off between the first and later periods of the circulation would be considerably below 30°.

The control of the battery in the distillery is identical with that in the sucrerie, with the exception that the valve V^1 is dispensed with, the valve V being adjusted as before. At the commencement of the circulation, the temperature of the juice leaving the diffuser is between 65° and 40°, as indicated by a thermometer on the juice outlet pipe. When the temperature drops to 40° (after about two minutes) the workman opens the valve leading to the measuring tank, simultaneously closing that connected with the compensator. The temperature of the juice then continues to fall during the *soutirage*, and only commences to rise when that operation is complete.

The workman then re-opens communication with the compensator, and closes the passage to the measuring tank, when, owing to the accumulation of juice in the compensator, the subsequent *meichage* is very rapidly effected.

If the battery works too rapidly, the motion of the juice is automatically regulated by the juice rising in the vertical pipe of the compensator until equilibrium is established. If it is desired to hasten the work, the compensator float influences the *meichage* as in the preceding case.

As adapted for operating two batteries simultaneously.

In this case also, our battery is controlled by the careful regulation of the *soutirage* to within a very few seconds of the required time.

The juice, to be drawn off from each battery, flows alternately to the compensator, and it is from the latter that the juice under circulation is drawn by the pump. Our two control-valves are adjusted to effect the circulation and the *soutirage* in one and the same period of time, 3½ minutes for example. We need not here consider the *meichage*, which is conducted in each battery whilst disconnected from the compensator, and which is consequently more rapid than the *soutirage*.

Under these conditions we have the following results:—

1. The battery furnishes the desired volume of juice in 3½ minutes, the circulated juice returning to the battery during the time that juice is being drawn off to the measuring tank. The level of the juice in the compensator remains at a-b (*Fig. 1.*)

2. The battery furnishes more juice as soon as the level of juice in the compensator rises in the vertical pipe to a point at which the counter-pressure equals that of the battery; this level will be a^1-b^1, for example.

3. The battery furnishes less juice when the level of juice in the compensator descends between a-b and a^1-b^1, the motion of the float then partially closes the outlet valve, causing a retardation of the *soutirage* and forced circulation, and tending to hasten the working speed of the battery.

THE BEET SUGAR PROBLEM.

The formation of the large combination of beet sugar factories in Michigan, under a central board of control, is doubtless intended to prevent the interference of the various factories with each other's beet supplies, and at the same time to diminish the expenses of organisation, or the so-called fixed charges. The beet sugar industry since its beginning in the United States has presented features entirely different from the salient features of the cane sugar industry. In the latter, from the beginning, the sugar planter was a planter in fact, producing his own supply of sugar cane and then manufacturing it into sugar. It is only during recent years, with the development of the central factory system, that the sugar factories have been enlarged beyond the capacity of their owners' fields, and have taken in the crops of the adjacent fields whose owners felt that they would realise larger profits by the sale of their cane crops than by their manufacture into sugar with their own less perfect sugar manufacturing apparatus.

In the beet sugar industry, from its beginning in this country, the sugar factories have looked to the farmers for their supply of beets, and have only consented to build factories where an ample supply of beets seemed probable or was actually contracted for. The earlier beet sugar factories failed because they could get no supply of beets, and did not themselves wish to engage in the culture. The problem of an adequate supply of beets is now presenting itself to the factories in Michigan, in Colorado, and in California. In the world generally there is no way of settling such problems except by paying higher and higher prices, until those who are to be depended upon for the production will find it to their interest to engage in beet culture rather than in other cultures with which they have been more familiar. With the recently prevailing prices in Louisiana, the prices paid for sugar cane have been from \$3·00 to \$3·50 per ton. The sugar beet produces about one-half more sugar per ton than does the sugar cane, and it would seem in order for the beet sugar factories to pay for a ton of beets about one-half more than the sugar planters of Louisiana pay their tenants and others for their sugar cane, or let us say, \$4·50 to \$5·25 per ton. And yet, so far as we know, no such prices have been paid for beets, or, if paid, only for some exceptional lots of very high sugar content. In Louisiana, thus far, the prices paid for cane have been paid for it indiscriminately, so long as it was sound, the variations in quality not being so great as to permanently establish any method for distinguishing between the better and worse canes.

In Europe, the beet sugar factory was first developed in France, and twenty-five years ago it was estimated that 85 per cent. of the

beets consumed in French sugar houses were produced by the stockholders of the houses, thus practically continuing the custom that prevailed in the cane sugar world, making the sugar producer and cultivator practically the same person. The beet sugar industry in Germany developed later, and some twenty-five years ago it was found that there already three-quarters or more of the beets consumed in the great factories in Germany were produced by the beet farmers who had no interest whatever in the sugar factory. They simply found that sugar beets were a more lucrative farm product than any others in which they could engage.

In connection with the termination of the sugar bounties in Europe, it was thought that there would be a great falling off in sugar production, and with a diversion of the great fields of Central Europe from their present beet culture back to wheat, rye, barley, and other cultures. This is not the case. A slight diminution occurred, but it will be found, doubtless, within a very few years, that the area in sugar beets in Europe will be greater than ever, and that the relief to the industry that may come from the abolition of the sugar bounties, will come from the greatly increased consumption of sugar in Europe. It is a notable fact, and has been for several decades, that in Germany, wherever a sugar factory has been built, the entire neighbourhood has taken on new life; the farmers have acquired more wealth and display it in improved buildings, better domestic animals, more of them and better furnishing of their residences, better waggons and carriages, and evidence of general social improvement all along the line. These men find that it is better to produce sugar beets than it will be to go back to the wheat industry, in which they have to compete with our great western plains, where wheat is produced by machine work and passes from the fields across the continent, and in great ships directly to Germany, with less hand labour for the whole transit than is generally had in Germany on the local production of wheat there. Our hope for any permanent appreciation of the values of sugars must come from its increased consumption, and not from any expected diversion of the European farmers to other industries. Further, if our western beet sugar factories expect to maintain or increase their supplies of sugar beets, they must pay for them prices that will lead the farmers to abandon wheat and other cultures, and go into that of sugar beets to a greater and greater extent.—*(Louisiana Planter.)*

THE CHEMICAL COMPOSITION OF MAPLE-SYRUP AND MAPLE SUGAR.

By a rough classification, accountable by the fact that sucrose constitutes their chief ingredient, so-called maple-syrup and maple-sugar have long been classed with products obtained from sugar-cane, sugar-beet and sorghum. The statement that the sugar of the maple sap is identical in composition with that of the sugar-cane has been currently accepted, hence it has been concluded that chemical methods are helpless as a means of distinguishing the syrup or sugar prepared from the sugar-maple from like products prepared from the sugar-cane. Commercial interests have taken advantage of the unsatisfactory state of chemical knowledge regarding maple products, and have been active in enforcing upon the popular mind the belief that pure maple-sugar is chemically identical with the well-known refined granulated sugar. Contrary to absurd opinions and interested claims, however, it is obvious that, beyond the point of identity as regards their sucrose content, so-called cane-sugar and maple-sugar are very divergent in composition and properties.

Maple-sap is essentially a dilute solution of sucrose, carrying, also, small amounts of proteids, organic acids (mainly malic), mineral matter (chiefly lime and potash) and traces of reducing sugars. During the boiling-down process some of the proteids are coagulated and rise to the surface, where they are removed by skimming, while a considerable amount of mineral matter (so-called "nitre" or simple dirt) is deposited at the bottom of the evaporator. The syrup, after being drawn, may be further clarified by filtering hot through felt strainers or by sedimentation. A product intended for use as syrup is commonly boiled down to a density of 11 pounds of syrup per gallon; if it is to be made into sugar, the syrup is boiled to a concentration such that it will harden on cooling. As is well-known, the value of maple-sugar is out of proportion to the saccharine matter which it contains, and is due to the peculiar pleasant flavour derived from certain minor ingredients carried in the sap. The nature of these flavouring substances has not been definitely determined, but that they are not wholly volatile is shown by the fact that they remain in the syrup during the process of concentration and may be retained in the sugar for a considerable time. The distinctly agreeable odor that accompanies the evaporation of maple-sap is familiar to anyone who has visited an orchard during the sugar season. The wide range in colour, from very light to very dark, characteristic of maple-syrups and sugars is attributable to various causes, chief among which are location and character of soil, time of season, and care taken in handling and boiling the sap. The first run of sap produces a much lighter-coloured syrup and sugar than

the later runs, which not only yield darker products, but impart flavours sometimes unpleasant to the taste. The first run is considered by all producers as by far the best for making a first-class product. Colour is, however, not a safe criterion as to quality or purity, and has little influence upon prices commanded in the general market, as it has long been suspected that very little of the pure article eventually reaches the consumer.

It has long been a matter of common report that there are sold on the market large quantities of alleged maple-syrups which are fabrications composed only in part of maple-syrup, or, as has often been the case, are entirely free from any maple product whatever. The requisite maple flavor has been imparted to such syrups, it is said, by mixing them with an extract prepared from hickory bark and sold extensively under the name of "mapleine." As claimed by its inventor, "The effect of the extract or decoction is to give to the syrup the flavor of the maple, producing a syrup which cannot be distinguished from genuine maple syrup." The simple practice of flavoring syrups with corn-cob infusions has, so far as known, probably not extended seriously beyond the bounds of rural communities or the domestic kitchen. There has recently been reported a process of preparing imitation maple-syrup, which consists in distilling maple or hickory chips with steam, adding sugar to the distillate, boiling down to the required density, then adding caramel if necessary. Various other processes, concoctions, flavours and essences have presented themselves from time to time, but these, in most instances, have been of such a character as not to merit serious attention. The use of so-called corn-syrup, or starch glucose, as an adulterant of maple-syrup has been practiced quite extensively for many years, but this form of adulteration, while very profitable to the manufacturer, has yielded an inferior article, and one which could easily be detected by the chemist, if not by the consumer.

Within the past fifteen years more or less complete analyses of maple products have been made and reported, notably by analysts of the United States Department of Agriculture, the Canada Inland Revenue Department, the Connecticut Agricultural Experiment Station at New Haven, and the Illinois State Food Commission. These analyses, with the exception of those reported from Canada, show little or no attempt to determine the properties of samples of known purity, and beyond the point of reporting adulteration with starch glucose, all analysts are cautious and seem to be of the opinion that it is impossible to say in regard to most samples whether they are spurious or genuine. The analysis of commercial maple-syrup has, therefore, in recent years, been confined chiefly to the detection of starch glucose.—(Abridged from *Journ. Amer. Chem. Soc.*)

OBITUARY.

Victor Beauduin.

Belgium has suffered a great loss in the death of an exceptionally able man. In the sugar world he held a high position as head of the important refinery at Tirlemont, of which town he was burgomaster; as Vice-President of the Society of Sugar Manufacturers, and Manager of the United Sugar Factories; and as Vice-President of the Superior Council of Agriculture. In all positions he was *facile princeps*, and was able, as member of the Belgian Parliament, with his accurate knowledge of the technicalities of the sugar industry, and his wide acquaintance with the sugar legislation of his own and other countries, to speak there with authority and to beheard with attention.

But it was in his position as Delegate at the International Conferences on the sugar question, and at the meetings of the Permanent International Commission at Brussels, that I had the best opportunity of appreciating his remarkable personality. He spoke seldom, but whenever he addressed us he enjoyed the distinction of receiving especially close attention from his hearers. What he said was always concise, lucid, full of accurate knowledge and well considered argument. He spoke slowly, and with much precision, and what he said always carried great weight with those who listened.

I am sure there is no member of those assemblies who will not regard his loss as very serious, not only to the Belgian industry and the Belgian Government, but also to all who desire to see the sugar industries of Europe maintained on the basis of free competition and equality of conditions.

George Martineau.

PUBLICATIONS RECEIVED.

The hobby of collecting picture postcards—those who do not collect call it a craze—has before now been turned to useful account for advertising public resorts, or the railways leading thereto. We have just been sent several sets of views of the West Indies taken by Mr. Algernon E. Aspinall, Secretary to the West India Committee, and published with the object of popularising those islands, which have been described as some of the brightest gems of the British Crown. Considering these are reproduced from amateur photographs, the results are surprisingly good, all the more when we bear in mind the difficulty of getting adequate graduations of light when a tropical sun is shining. The series are as follows:—

I.	West Indian Views.	II.	West Indian Life.
III.	Barbados.	IV.	British Guiana.
V.	Jamaica.	VI.	Trinidad.
VII.	Grenada.	VIII.	St. Lucia.

One of the Trinidad views is of the well-known Usine St. Madeleine, which is clearly depicted. The views of the West Indian Life are particularly good. The cards are executed by Messrs. Raphael Tuck & Sons, and are obtainable from Mr. G. P. Osmond, 15, Seething Lane, London, E.C. Series I. and II. are in packets of twelve, the rest in packets of six; and the price is one penny per card.

Correspondence.

SUGAR REFINING WITHOUT CHARCOAL.

To the Editor of "The International Sugar Journal."

In No. 69 (September, 1904) of *The International Sugar Journal* appears an article headed "Sugar Refining without Charcoal," by Mr. Sig. Stein. As such an article is very misleading for those who really intend to do as the author proposes, I will try in these lines to criticise and correct same.

An average analysis of jaggery, from five different places in the British East Indies, gave the following composition:—

Pol. (direct)	77·5°
Ash	3·2%
Glucose	7·1%
Water	8·2%

App. purity ± 85.

Jaggery is a sugar or rather a masse-cuite of nearly the same appearance as the well-known West Indian "Muscovado," which is sold on basis 89° Pol., thus being somewhat better. When the jaggery is dissolved in water, it gives a liquor at least as pure as any ordinary cane juice (pur. 80-90), and may yield white sugar as good as any cane or beet juice of the same purity.

In America (and also in Austria and Germany so far I can remember) white, so-called "granulated," sugar is made in most factories from beet juice without any use of bone-black (charcoal) filters. I have seen just as pure white sparkling sugar made from rotten beets as that from refineries in New York.

After double carbonatation, the juice is treated with sulphurous gas, this treatment being repeated after concentration to syrup.

In Australia many factories make a pure white sugar without using bone-black filters. Either the raw mill juice is sulphured right away or else it is treated with the gas after liming. The alkalinity of the juice is kept as near to the neutral point as possible. The syrup must be neutral. If alkaline, it becomes coloured during boiling; if acid, inversion will take place.

Here, in Java, the same proceedings are conducted. The masse-cuite is dried very thoroughly before washing with water and covering with steam. The sugar is either granulated, or cube, or "yellow

Demerara" (big, white grains washed with "Caramel" or Orleans). In many other places white sugar is made in the same manner. The bone-black filters are disappearing. But as to Mr. Stein's process:—

1. A double bottom is not necessary in the melting pan. A coil arrangement is just as good and cheaper. The mixture has a density of *ca.* 50° *Bé*. A little lime is added (to weak reaction with Phenolphtalein), this being necessary, not only for the liming treatment but also because the jaggery is often acid.

2. Filtration through filter presses is impossible on account of its slimy character, unless re-agents have been added. Bag filters are cumbersome and expensive.

3. For this reason alone it is not advisable to boil the liquor without lime.

The liquor from the melting pan is then let into the saturation pans, where sulphurous gas is introduced. When the alkalinity just colours litmus paper blue, the gas must be shut off within 30 seconds, and at the same time open steam is turned in.

The liquor is now about 80°-90° C., and contains a precipitate that settles very easily. The liquor is then fit for filtration through filter presses. The press cakes may be stirred up with water, the mud allowed to settle, and the wash-juice used in the melting pan again, thus recovering some of the sugar lost in the cakes.

The double installation of filter presses and pumps is then unnecessary, and only melting pans for jaggery are needed. Instead of filter presses, very often Scheibler's or Danek's filters are used.

The subsequent boiling of the clear liquor to masse-cuite, the mixing of this, &c., &c., must of course be done thoroughly to obtain good results, but it is not at all necessary to leave the masse-cuite in the crystallizers or mixers for ten hours. The time depends upon the consistency of the masse-cuite, and the experienced sugar boiler knows when it is fit for curing.

Syrup is drawn in till the purity is about 80.

The sugar must be cured well before washing with water, blue, and steam. If there remains too much syrup, this may be boiled to a No. 2 strike, making a fine yellowish, marketable sugar.

To me it is obvious that Mr. Stein's process is costly and destructive to the sugar. Two installations of presses and pumps, two melting pans, two pans for his No. 1 sugar and for his refined sugar, besides one pan necessary for No. 2. Many centrifugals are needed, much of the sugar having to be cured twice; moreover, the sugar liquors suffer from too many boilings.

Whether this kind of refinery will pay or not I dare not say, but I doubt it. Even if the waste molasses are burned, much extra fuel has to be used. It is much cheaper to erect a sulphuring installation in the factories.

GUNNAR HAGEMANN.

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. THOMPSON, C.E., F.C.S., M.I.M.E., Chartered Patent Agent, 6, Lord Street, Liverpool ; and 322, High Holborn, London.

ENGLISH.—APPLICATIONS.

21865. J. R. HATMAKER, Paris, France. *Improvements in process of obtaining milk sugar and casein from milk.* 11th October, 1904.

23579. A. G. FISCHER, London. *A combined self-operating sugar sifter and graduator.* 1st November, 1904.

24366. B. YOUNG, London. *Improvements in and relating to bins for sugar and other materials.* 10th November, 1904.

24374. B. T. KING, London. (Communicated by C. H. BERTELS, Belgium.) *Process for the separation of alkaline salts contained in sugar juice and the subsequent extraction of crystallisable sugar.* 10th November, 1904.

24575. J. C. F. LAFEUILLE, London. *Improvements in sugar moulds.* 12th November, 1904.

ABRIDGMENTS.

15297. V. DREWSEN, New York, United States of America. *Process of manufacturing products from cornstalks, sugar cane and analogous pithy stalks.* 8th July, 1904. The difficulty in preparing fibrous material (cellulose), or other products suitable for the manufacture of paper from these pithy stalks lies in the different character of the different parts of the stalk. A corn stalk proper, namely without leaves or husks, for instance, consists of two parts which can be used by paper manufacturers, to wit, the outside shell and the pith. The shell has a character similar to wood and contains a high percentage of fibres, while the pith is spongy and consists principally of oblong cells. This is also true of the sugar cane.

Copies of all published specifications with their drawings in these lists can be obtained from W. P. Thompson & Co., 6, Lord Street, Liverpool, at One Shilling a copy for English or American Patents, and Two Shillings for German. In ordering please give number and date.

IMPORTS AND EXPORTS OF SUGAR (UNITED KINGDOM)

To end of October, 1903 and 1904.

IMPORTS.

Raw Sugars.	Quantities.		Values.	
	1903.	1904.	1903.	1904.
	Cwts.	Cwts.	£	£
Germany	4,369,534	5,175,987	1,836,825	2,377,715
Holland..................	184,109	405,291	71,152	205,719
Belgium	658,501	551,925	272,903	273,292
France	524,246	473,627	229,534	247,266
Austria-Hungary	1,542,961	688,203	646,458	310,628
Java	359,537	1,679,414	174,602	780,581
Philippine Islands	70,646	87,025	25,285	31,165
Cuba	445,166	....	215,443	....
Peru	301,891	900,394	124,895	423,311
Brazil	67,639	83,257	26,394	31,607
Argentine Republic.........	418,369	....	184,709	....
Mauritius	264,311	525,292	94,346	198,838
British East Indies	264,420	192,817	97,127	78,319
Br. W. Indies, Guiana, &c.	565,883	840,288	340,280	543,045
Other Countries	453,319	434,944	197,525	202,659
Total Raw Sugars......	10,490,532	12,038,464	4,537,478	5,704,145
Refined Sugars.				
Germany	12,640,647	8,697,125	6,618,979	4,962,330
Holland..................	1,833,314	2,613,080	1,065,727	1,587,958
Belgium	113,379	432,690	66,524	253,682
France	758,556	2,368,859	429,252	1,356,885
Other Countries	861,794	179,991	426,662	95,370
Total Refined Sugars ..	16,197,690	14,291,745	8,607,144	8,256,225
Molasses	1,284,427	1,448,708	235,520	271,067
Total Imports	27,972,649	27,778,917	13,380,142	14,231,437

EXPORTS.

British Refined Sugars.	Cwts.	Cwts.	£	£
Sweden and Norway	30,107	29,942	15,047	16,379
Denmark	82,363	90,166	44,867	46,191
Holland	56,853	55,152	30,689	30,363
Belgium	9,986	9,709	5,072	5,325
Portugal, Azores, &c.	8,176	16,757	4,647	9,224
Italy	7,472	3,508	3,442	1,676
Other Countries	653,713	304,472	400,714	199,811
	848,670	509,706	504,478	308,969
Foreign & Colonial Sugars.				
Refined and Candy	35,772	21,327	22,258	14,847
Unrefined	52,932	93,258	27,957	51,778
Molasses	1,867	1,835	892	1,022
Total Exports	939,241	626,126	565,585	376,616

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1904. Tons.		1903. Tons.
Total Receipts, Jan. 1st to Nov. 17th ..	1,785,775	..	1,490,436
Receipts of Refined ,, ,, ,, ..	569	..	1,264
Deliveries ,, ,, ,, ..	1,794,651	..	1,456,015
Consumption (4 Ports, Exports deducted) since 1st January	1,712,322	..	1,526,587
Importers' Stocks (4 Ports) Nov. 16th ..	3,285	..	36,806
Total Stocks, Nov. 30th.	129,000	..	100,387
Stocks in Cuba, Nov. ,, ...	1,000	..	122,000
	1903.		1902.
Total Consumption for twelve months ..	2,549,643	..	2,566,108

CUBA.

STATEMENT OF EXPORTS AND STOCKS OF SUGAR, 1903 AND 1904.

(Tons of 2,240lbs.)	1903. Tons.		1904. Tons.
Exports	826,108	..	1,078,906
Stocks	158,593	..	16,916
	984,701	..	1,095,822
Local Consumption (nine months)	30,720	..	32,721
	1,015,421	..	1,128,543
Stock on 1st January (old crop)	42,530	..	94,835
Receipts at Ports up to September 30th ..	972,891	..	1,033,708

Havana, 30th September, 1904. J. GUMA.—F. MEJER.

UNITED KINGDOM.

STATEMENT OF IMPORTS, EXPORTS, AND CONSUMPTION FOR TEN MONTHS ENDING OCTOBER 31ST.

SUGAR.	IMPORTS. 1902. Tons.	1903. Tons.	1904. Tons.	EXPORTS (Foreign). 1902. Tons.	1903. Tons.	1904. Tons.
Refined	783,771	809,884	714,587	2,041	1,788	1,066
Raw	557,334	524,526	601,923	3,841	2,646	4,663
Molasses	57,084	64,221	72,435	126	93	92
Total..........	1,398,189	1,398,631	1,388,945	6,008	4,527	5,821

	HOME CONSUMPTION. 1902. Tons.		1903. Tons.		1904. Tons.
Refined..	782,718	..	757,276	..	728,027
Refined (in Bond) in the United Kingdom	—	..	16,692	..	438,778
Raw	531,336	..	402,358	.	106,593
Molasses	53,330	..	58,990	..	70,914
Molasses, manufactured (in Bond) in U.K.	—	..	4,377	..	50,034
Total..................................	1,367,384	..	1,239,693	..	1,394,346
Less Exports of British Refined......................	30,081	..	42,433	..	25,485
Total Home Consumption of Sugar	1,337,303	..	1,197,260	..	1,368,861

Stocks of Sugar in Europe at uneven dates, Nov. 1st to 30th, compared with previous Years.

In thousands of tons, to the nearest thousand.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	Total 1904.
86	543	482	282	74	1467

	1903.	1902.	1901.	1900.
Totals	2020 ..	1865 ..	1570 ..	1239

Twelve Months' Consumption of Sugar in Europe for Three Years, ending October 31st, in thousands of tons.

(Licht's Circular.)

Great Britain.	Germany	France.	Austria.	Holland, Belgium, &c.	Total 1903-4.	Total 1902-3.	Total. 1901-2.
1714	1093	693	486	199	4189	3697	3682

Estimated Crop of Beetroot Sugar on the Continent of Europe for the current Campaign, compared with the actual crop of the three previous Campaigns.

(From Licht's Monthly Circular.)

	1904-1905. Tons.	1903-1904. Tons.	1902-1903. Tons.	1901-1902. Tons.
Germany	1,660,000 ..	1,933,435 ..	1,762,461 ..	2,304,923
Austria	950,000 ..	1,177,210 ..	1,057,692 ..	1,301,549
France	685,000 ..	804,401 ..	833,210 ..	1,123,533
Russia	1,000,000 ..	1,200,000 ..	1,256,311 ..	1,098,983
Belgium	190,000 ..	203,446 ..	224,090 ..	334,960
Holland	125,000 ..	123,551 ..	102,411 ..	203,172
Other Countries.	340,000 ..	410,000 ..	325,082 ..	393,236
	4,950,000	5,852,043	5,561,257	6,760,356

Date of issue.	Date of issue.	Date of issue.